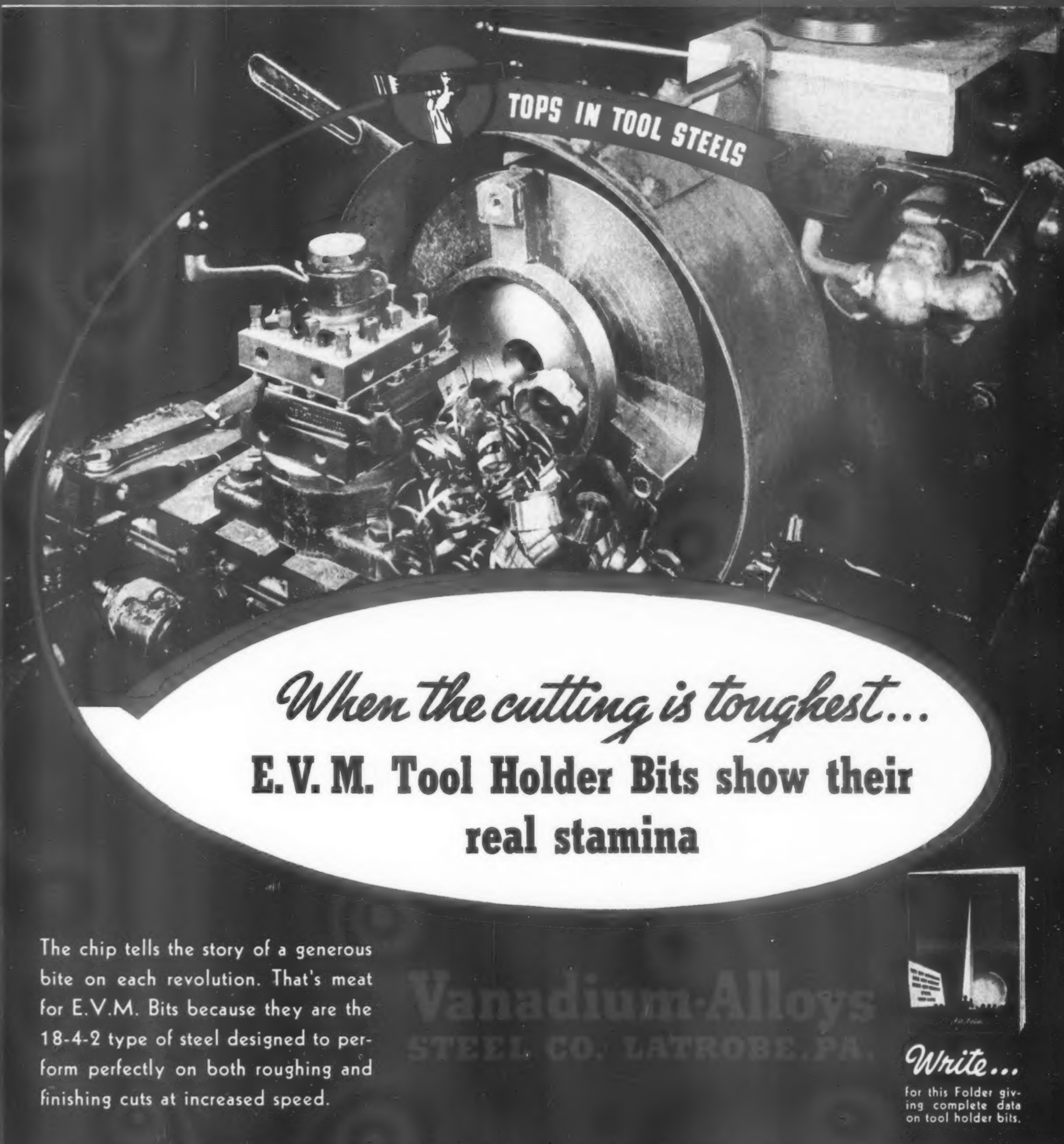
The TOOL ENGINEER

APRIL, 1939
Show and Souvenir Edition



Official Publication of the
AMERICAN SOCIETY OF TOOL ENGINEERS

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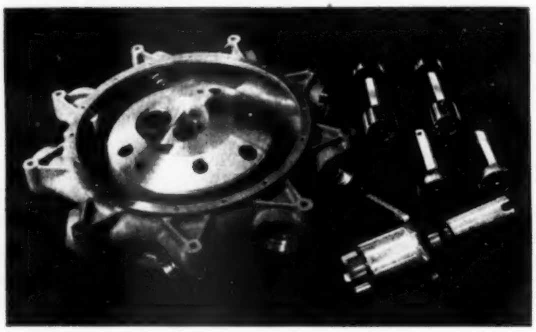

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The Tool Engineer

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Official Publication of the AMERICAN SOCIETY OF TOOL ENGINEERS

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Contents

Application blanks and information pertaining to membership in the American Society of Tool Engineers may be had by addressing **The Tool Engineer**, 2842 W. Grand Boulevard, Detroit, Michigan, or the Secretary's office, 2567 W. Grand Blvd., Detroit, Michigan. **Dues** are $5 initiation fee, $6 per year for senior grade membership and $3 per year for junior grade membership. Junior membership initiation fee $2.

The Tool Engineer is published approximately the first of each month. It is the official publication of the American Society of Tool Engineers, Incorporated. The membership of the Society and readers of this publication are practical manufacturing executives such as master mechanics, works managers, Tool Engineers, tool designers and others who are responsible for production in mass manufacturing plants throughout the nation and in some foreign countries.

Owing to the nature of the American Society of Tool Engineers, a technical organization, it cannot, nor can the publishers be responsible for statements appearing in this publication either as papers presented at its meetings or the discussion of such papers printed herein.

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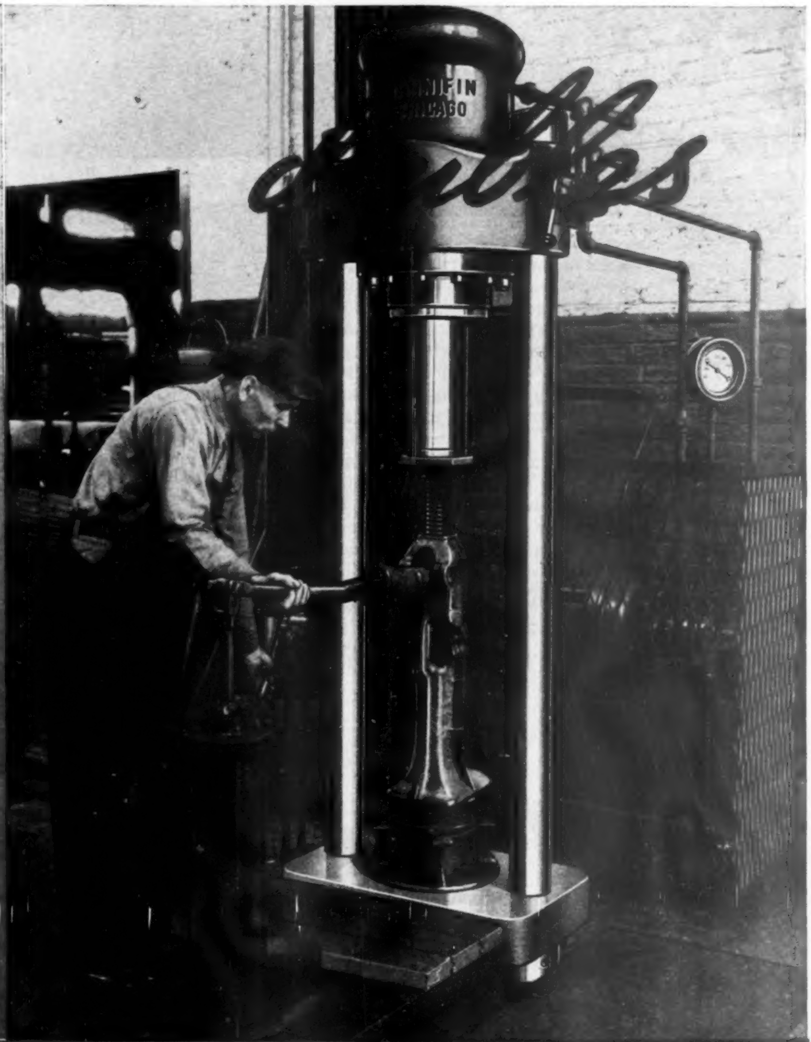

HANNIFIN HYDRAULIC PRESSES

JAMES R. WEAVER

New President of A. S. T. E.

SAYS—

THE Second Machine and Tool Progress Exhibition is now behind us. It is hardly necessary for me to repeat here what a huge success it was. Those who attended came away with many new ideas which they will use in lowering the cost, increasing the output, and improving the quality of their particular products. But there were also other and more fundamental things to be seen at the show provided one looked beyond the mass of steel and alloys comprising the material side of the exhibits.

I do not wish to appear pessimistic, but there are three lessons to be drawn from our recent Machine and Tool Progress Exhibitions that I wish to mention here.

Some of you heard the preliminary report of Prof. Younger's Fact Finding Committee. This report made it plain that, in view of the facts collected so far, the machine creates jobs. This is the conclusion reached by all those who have been intimately associated with machines for a number of years, and this is true if a long range view is taken of the situation. However, machines and machine tools are oftentimes responsible for temporary unemployment. That is, the immediate effect of installing a new machine is, generally speaking, to lower labor costs by increasing the production per capita. Another way of saying this, and the form in which you have heard it is, that the machine increases human efficiency. The end result is the same.

Therefore when contemplating the purchase of new labor saving tools, one of the things to be considered by management should be the number of men expected to be displaced by the new machine. Then management should plan to take proper steps for absorbing this superfluous labor in other activities or rehabilitate it by proper training.

The second lesson to be drawn from this tool show and convention is that the Tool Engineer has definitely "arrived." He is receiving more recognition every day as a factor in the development of new and improved processes, machines and tools. He is directly responsible for making the transfer of skill from man to machine. However, he has not been able to transfer pride of workmanship to the machine. This means that the relatively unskilled labor of today will have to be educated to watch the product of the machine for quality. Tools will get dull, setups will need adjustment, and dies will wear, but the machine will continue to produce—oftentimes defective pieces. The operator will have to learn that his is the hand that guides the machine.

The third lesson is that many people consider the Machine and Tool Progress Exhibition as another sign pointing to the gradual elimination of trained workers. Industry will have to take aggressive steps to correct this condition. Skilled men are needed to operate the machines which perform the complex operations of today. But after staying in school until he is eighteen, as required by most states, a boy does not want to bond himself to a four-year apprenticeship course. Therefore the question arises—where and when is he going to acquire his skill as a machine operator?

The answer is simple. We need more vocational schools, better equipped with machines and instructors, so that the boys can step out of high school and take their places in the production lines and thus make them useful citizens. Just as the engineering profession is taking an active part in preparing the curriculum presented in our larger universities, industry must work with boards of education in order to prepare suitable training courses for those who do not expect to continue their formal education beyond high school.

James R. Weaver

PRESIDENT
AMERICAN SOCIETY of TOOL ENGINEERS

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1939-1940

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A. S. T. E. SHOW AND CONVENTION SET RECORD

Over 77,000 total attendance at show and the largest convention of its kind, heralds the progress of American Society of Tool Engineers as unparalleled in the history of technical associations.

FACTS, figures and the consensus of opinion all give the recent convention of A.S.T.E. and the Machine & Tool Exhibition a big lead on all fronts over other events of their kind.

With a total attendance authoritatively estimated at 77,500, including 27,342 registrations from bona fide members of the profession and industry—with over 60 per cent attendance from other states than Michigan—the Exhibition closed Saturday evening, March 18th, in a burst of glory for the Society, business for the exhibitors and professional advancement for Tool Engineers.

The 253 individual exhibitors who displayed and demonstrated their tools, materials, processes and machines in 241 separate exhibits were unanimous in their praise of convention arrangements, facilities and results.

Highly appreciative of the quality as well as the volume of attendance, these exhibitors individually and collectively expressed their admiration at the intelligence, seriousness and authority of visitors to the show.

Noteworthy in the event was its typical American character. In a world fantastic in its complexity of motive, strategics and objective, the Exhibition as well as the tone and matter of Convention Sessions, exemplifies the clear cut American way of production for peace and profit (and everybody's profit!)

Momentous was the preliminary report of the Fact Finding Committee. Here were presented organized data and logical findings on the relation of the machine and the machine tool to employment. First among learned organizations the American Society of Tool Engineer took definite steps to study and to understand fully the social effect of the forces which he develops and with which he works.

Highly significant of a vigorous spirit and sense of responsibility was the Society's determination to as far as possible make its findings immediately effective. President-elect Weaver's first move was a recommendation that Tool Engineers furnish their respective managements with names of men who may be temporarily displaced through the introduction of new machines and processes, so that provision for these men may be considered as an integral part of the problem.

Tours Well Attended

Approximately one thousand of the visiting Tool Engineers took advantage of invitations extended to the American Society of Tool Engineers to visit the more important plants in the Detroit area. Forty-eight Detroit Street Railway busses were engaged to transport the visitors to the various plants. The Tool Engineers making these trips expressed their satisfaction both with the transportation facilities provided as well as with the splendid trips arranged in the plants. In many cases the engineers were not required to "stay back of white lines" as is generally required on public inspection trips. Often special tool men were provided as guides in the plants.

Preview Dinner

Indicative of the high standing of the Tool Engineer in the community, as evidence of the increased interest in the importance of his work as well as his attitude towards it, was the long list of distinguished guests and speakers at the Preview Dinner.

Noteworthy were John R. Caton, Director of the Chrysler Institute of Technology; Wendall Whipp, President, National Machine Tool Builders Association; Nicholas Dreystadt, President Cadillac Motor Car Company; Dr. Edgar DeWitt Jones, Pastor, Detroit's Central Woodward Christian Church, and Past President, Council of Churches of Christ in America; K. T. Keller, President, Chrysler Corporation; Alvin Macauley, President, Packard Motor Company, and President, Automobile Manufacturers Association; Warren Bow, Director of Vocational Education, Detroit Board of Education; Reverend Father A. H. Poetker, President, University of Detroit, William B. Stout, President, Stout Engineering Laboratories; James Parker, President, Detroit Engineering Society.

Called to order by Toastmaster L. Clayton Hill, Manager of Manufacturing, Murray Body Corporation, the assembly, after a brief introduction by President Walter F. Wagner, heard the preliminary report of the Fact Finding Committee delivered by Committee Chairman Professor John Younger, Ohio State University, and the address by Dr. Harold G. Moulton, President, The Brookings Institution.*

The Exhibition

The Exhibition was well attended at all times from the moment of opening to close. Tuesday, the first day, found W. S. Knudsen, President of General Motors Corporation, Alvin Macauley,

*Professor Younger's report is printed in full beginning on page 13, Dr. Moulton's on page 16.

International Harvester Company executives, spending $12,000,000 on plant modernization and expansion, were interested visitors to the Machine and Tool Progress Exhibition. They are seen, above, discussing a new method of producing ring gears. Left to right: B. F. Bush, Colonial Broach Company; Hugo A. Weisbrodt, assistant Superintendent International Harvester; Charles R. Staub, Chief Engineer, Michigan Tool Company; C. M. Harrison, General Superintendent of International.

President of Packard Motor Company, and many other high figures in industry from all over the country among the interested visitors. At times the crowd grew so fast that the more than 20 people on the registration desks could not keep pace with typing badges.

Commented on by various exhibitors was the smoothness and efficiency of arrangements. Thanks to able, tireless work by the committee in charge, headed by Ford Lamb, installation of machinery and exhibits was accomplished quickly, adequate supplies of gas, electricity, water and compressed air were continuously available.

Committee Organizations

Fact Finding Committee met Tuesday evening, March 21, discussed their preliminary report and after consideration of its general reception, laid plans for a continuance of this work with a view to elaboration of data and a refinement of conclusions.

Constitution and By Laws Committee gathered on the following evening, Wednesday, to revise the constitution in order to provide for more efficient operation to keep pace with larger problems due to the Society's rapidly accelerated growth.

The STANDARDS COMMITTEE met on Friday, March 17, to review work accomplished on the compilation of data sheets and to make plans to promote a better working knowledge of this work among the various Chapters.

Board of Directors

Thursday morning, March 16, found the Board of Directors in session. While all phases of Society business were considered and acted upon, outstanding decisions were dates for the next meeting and a subsequent exhibition.

A Semiannual Meeting will be held in Cleveland during October on specific dates to be announced later. It is proposed that the Society sponsor one or two technical meetings in connection with the National Machine Tool Congress.

It was voted to hold the next Machine & Tool Progress Exhibition in 1941. An interim of two years between shows was considered essential to permit proper development of new tools, materials and processes.

Over 2,000 Attend Technical Session

Setting what is believed to be a new record for attendance at technical meetings, the first session of the Society on Wednesday evening drew an audience of well over 2,000 Tool Engineers and factory production executives. This session was devoted to all phases of surface finishing.

On Friday evening, the meeting on "New Developments and Their Effect on the Tool Engineer" was almost as well attended.

C. J. Oxford, Chief Engineer, National Twist Drill & Tool Co., presided at the first session, with Chris Borneman, Supervisor, of Tool & Gage Service Department, General Electric Co., holding the gavel at the last meeting.

Complete text of papers read at these meetings is printed on subsequent pages of this issue of "The Tool Engineer."

Annual Dinner

Over 600 Tool Engineers and their guests heard William B. Stout as the featured speaker at the Annual Dinner held at the Book Cadillac Hotel, Thursday evening, March 16.

This dinner saw the installation of the new officers, Walter F. Wagner, retiring President, turning over the gavel to James R. Weaver, Director of Equipment, Purchases, Inspection and Tests, Westinghouse Electric and Manufacturing Co., and President of the Society for the coming year. (Complete roster and pictures of incoming officers will be found elsewhere in this issue.)

William (B for Bill) Stout, President Stout Engineering Laboratories, and noted for his inventions and developments in connection with all-metal aircraft, lightweight rail cars, rear-engined motor cars, told Tool Engineers that for every engineering invention introduced to the public probably a thousand inventions in connection with machines, tools, fixtures and processes are required to make its larger use possible.

In many cases, Mr. Stout said, inventions accepted by the public are directly traceable to the development of a new machine or process which made production of the invention possible. Mr. Stout mentioned hypoid gears for motor car rear axles as a case in point, owing its wide use to the development of special machinery to produce gears of this new shape.

Members Receive Mileage Rebate

The Society voted the payment of rebates of two cents per mile traveled to the Exhibition and Convention by members in good standing. In many cases, the Executive Committee points out, this rebate far exceeded the annual membership dues to the Society.

1939 Committee Structure

The first meeting of the newly elected officers was held Friday evening, March 17. At this session the following committee structures were appointed and inducted into office:

MEMBERSHIP: Conrad Hersam (Philadelphia), Chairman; Nils H. Lou (Baltimore); Frank Sheeley (New York).

STANDARDS: J. Don Reep (Buffalo), Chairman; Joe De Montigny (Detroit); Eugene Bouton (Racine).

CONSTITUTION & BY LAWS: R. M. Lippard (Worcester), Chairman; I. F. Holland (Hartford); C. E. Ives (Chicago).

INDUSTRIAL RELATIONS: George Smart (Cleveland) Chairman; Eldred A. Rutzen (Milwaukee); E. W. Ernest (Schenectady).

PUBLICITY: U. S. James (Detroit), Chairman; Frank Oliver (New York); George Wise (Minneapolis).

EDITORIAL: George Keller (Buffalo), Chairman; A. E. Rylander (Detroit); Earl Johnson (Dayton).

HISTORICAL: O. B. Jones (Detroit), Chairman; Joseph Siegel (Detroit); A. M. Sargent (Detroit).

NEW CHAPTERS: Roy T. Bramson (Detroit), Chairman; committee also includes all Executive Officers.

NOMINATING: Membership of this committee are elected by the members.

A long arduous day had preceded the taking of the photograph shown above. The A.S.T.E. Board of Directors really works. Each chapter chairman, an ex-officio member of the board, is an ardent exponent of A.S.T.E. and sure to "represent" his chapter according to his best abilities.

MACHINE TOOLS *Create* EMPLOYMENT

A preliminary report of the A.S.T.E. Fact-finding Committee as given at the Pre-view dinner A.S.T.E. Machine and Tool Progress Exhibition, Detroit, March 13, 1939.

By
PROF. JOHN M. YOUNGER
OHIO STATE UNIVERSITY
CHAIRMAN, A.S.T.E. FACT-FINDING COMMITTEE

PROF. JOHN M. YOUNGER

FROM time to time the machine tool, even the machine, comes under fire, and abuses are heaped on it. The main theme is that the machine tool creates unemployment.

Realizing this fact, Mr. Ford Lamb, Executive Secretary of The American Society of Tool Engineers, called a meeting of representative members and the idea was advanced that what was wanted were facts about the subject. This marked the inception of the Fact Finding Committee. Since then we have had two very successful meetings. We entered into considerable correspondence and everybody put his shoulder to the wheel, with the result that the report placed before you began to take form. It is now presented to you as a preliminary or interim report. After we have accumulated and assimilated much more data which is available, we will present a later and even more conclusive report. The following expresses some of the high lights of the report:

First we make a distinction between the machine and the machine tool. The machine is the final product. It creates nothing. The machine tool is the creator. The machine, as you all know, has contributed immeasurably to our comfort and satisfaction. Yes, actually to our civilization! But the machine tool first of all has made the machine possible and, secondly, cheaply possible, so that masses can enjoy the benefits as well as the wealthy.

The Machine Tool and the Product

In our report you will find Mr. Cameron of the Ford Motor Company making the striking statement that a Ford of today as made by old time hand methods, without the advantage of today's tools, would cost $17,850. At this cost, he adds, no more than 50 cars would be sold. What a contrast to the 4,000,000 or 5,000,000 that are now sold each year, giving employment to millions.

An even more striking example is given by Mr. James R. Sheldon, President of the Ingersoll Waterbury Watch Company, who states that the labor cost of processing his watches by old machine shop methods would be $1040 each. Under present day factory methods these watches retail today for $1.50.

Mr. Charles R. Hook, President of the American Rolling Mill Company, states that in 1923 cold rolled sheet steel was $102 per ton. By the use of modern tools this figure was reduced to $59.00 a ton in 1935. The result considerably increased sales for the steel itself as well as for the products made from the steel, and, hence, increased employment all around. Mr. Hook says distinctly "The new-type mills have resulted in a decided increase in the number of men employed."

The population of our country increased from 1878 to 1938 by 2.6 times and it is significant to note that this large increase in working population was almost entirely absorbed in work possibilities. In fact, jobs in factories increased three times during this period.

Widening Ripples

The comparison has been made that it is like a stone thrown in a pool; the ripples caused reach out to the very edge of the pool. Your dark-shirted workman gives employment in turn to many more. The increasing sales demand an increasing number of so-called white collar men. You must have more salesmen, you must have more service men, you must have more advertising (which makes our present day magazines possible), and you must have more service facilities.

Observe the experience of one industry alone—the automotive industry —it has a host of salesmen, dealers, garage men, filling stations, men designing highways. Even the little hot dog stand proprietor along the main road owes his living directly to the automobile. Figures are difficult to obtain, but it is estimated that up to 10,000,000 people owe their living to the automotive industry. 10,000,000 new jobs created in 40 years is surely a wonderful thing.

Minimizing Factors

Now let us turn to the adverse factors which serve to minimize the effect of the machine tool in reducing costs. The first factor is undoubtedly that of taxation. The costs of government are rising rapidly. Tax collections of Federal, State and local governments now equal about seventeen percent of our national income. This percentage is approximately double that prior to the depression in 1929. It is estimated that today taxes, hidden and open, amount to $377 a year per family. The government debt represents an increase of over 1000 percent above the 3 billion dollar debt in 1900. Thus the public debt for each individual in the United States has increased from $40 in 1900 to $442 in 1938. What does this mean?

Your single man spending $108 a year for clothing has its cost increased by taxation $8.64 exclusive of local sales taxes. Taxes have been woven with the fabric of every stitch he wears. Such conditions tend to reduce purchasing power and to stimulate unemployment.

Women—A New Employment Factor

Secondly, there is the effect of women on employment. During the World War when there was such a shortage of man power for our army and our industries, women, feeling they could do their share of work, volunteered for duty in our factories. It was found that these women workers were just as stable as men, just as capable at certain monotonous tasks and in some cases even more efficient than men. Consequently, a desire to increase woman labor showed itself and today many factories are utilizing woman help to a remarkable degree. This actually means that while our working population has grown with the normal increase of the general population, a new factor has been introduced —we have tapped into a new population which in time has served to act as a means of reducing employment for men. It is apparently difficult to get figures of women workers but it is enough to say that they are a definite factor in the employment situation.

Costs of Distribution

The third factor, and one of which we can say little, lies in the costs of distribution and their effect on the ultimate cost to the consumer. We have seen how machine tools have decreased costs. However, distribution costs have not come down in similar proportion, and in fact seem to be, if anything, increasing. This problem is one that should be studied intensively. Indeed, it has, but so far no method of reducing these costs has resulted.

The Machine and The Tool

Now let us revert to the machine tool which has created the machine. The machine and the tool are inextricably conjoined. The one without the other is impossible. We cannot produce the machine without the tool. The tool is

valueless unless it has a machine to produce. So what affects the one affects the other. When we talk of putting a tax on the machine tool, we are actually putting a tax on the machine, and, as we already have taxed the machine—automobiles and radios, for example, we have actually been taxing the tool. We do not want to establish a double taxation. Let us face the facts: A tax on machine tools would increase the price of the machine and so cause fewer sales and in effect less employment.

Let us quote from Mr. J. H. Van Deventer, Editor of Iron Age, in the issue of June 9, 1939:

"At the beginning of this century, the entire population of Detroit, Lansing, Flint, Pontiac and Akron—now typical automotive cities—was 368,000. Today the population of these five cities aggregates more than 2 millions. They have multiplied themselves over five times in the past 38 years.

"Contrast this quintupling of population in these automobile cities with the mere tripling of population in the same period of Buffalo, Cincinnati, Chicago and New York, or with the lesser growth of only 70 percent for the continental United States as a whole.

"They came for the same reason that made our forefathers flock to California in 1849 and to the Yukon in 1896. They came to Detroit because men had discovered gold there—the gold of employment opportunity. People came to Detroit and to her sister cities because there was work for them to do. There was money to be earned in wages and in profitable enterprise.

"1929 was a good year for motor car sales. Production in that year for domestic and export sale was 5,400,000 cars in round numbers contrasted with 4,800,000 in 1937.

"Yet in spite of an annual output smaller by 600,000 units, employment in the industry was 15 percent greater in 1937 than it was in 1929. If you contrast this with the 6 percent increase in the population growth over the same period, you will note that the operation of the machines of the automobile industry did not destroy jobs for men and women; on the contrary, it created new jobs at a rate 2½ times faster than that necessary to maintain an employment balance.

Automotive Industry Increases Employment

"Thus you will agree—you must agree, for the unassailable figures prove it on both of these bases—that there has been no technological displacement whatever of labor in the aggregate in this industry, but, on the contrary, the industry has done more than its expectable share to "take up the slack" and to reduce unemployment."

There is no question, then, but that machines definitely create employment. The question may next be asked, "Well, that may be true of the early beginnings of the machine tool, but recent progress has been too fast. Invention has been outstripping employment and today your machine tools are displacing men from jobs."

1929 was a boom year. There were relatively few people unemployed and there was no question but that the machine tool was largely responsible for the vast amount of work being done. So that we can point with certainty to 1929 as a year in which we could say that, up to that time, machine tools created employment.

Then came the depression. We know now that this depression was not caused by the machine. We know that in its initial stages the machine had nothing to do with it, but the question arises, has the machine tool with its great work possibilities prolonged the depression?

Let us begin, then, with 1930. We quote from Machinery, Employment and Purchasing Power of the National Industrial Conference Board:

"It is significant in view of the claim that extensive unemployment has been caused by the introduction of the labor saving machinery that in the census of 1930 the number of workers who attributed their unemployment to this cause is so small. In a total of 3,633,896 returns reporting unemployment in this census, only 10,651 persons, or less than one-third of one percent, gave 'Machinery introduced' as the reason for their unemployment. It is safe to assume that the installation of this type of machinery does not take place without the knowledge of the worker whose means of gaining a livelihood is threatened by it."

Further, from the same source, "But considering the general attitude of workers toward the introduction of labor saving machinery, the number who attributed their unemployment to this cause is likely to represent too large rather than too small a proportion of the unemployed."

But after 1930—have we gone too fast —have we introduced too many machines? Well, here are the facts: The machine tool industry was not spared from the effects of the depression. In fact, it suffered as badly as did other industries. Many a shop in the Cincinnati, Rockford and New England territories were virtually if not absolutely shut down and there was very little, if any, production of machine tools. Hence, the blame for the continuance of the depression cannot be laid at the door of the machine tool industry. You cannot make bricks without straw. You cannot displace men by machines which were never built.

Machines Still Create Employment

There comes the question, "Well, we believe that machine tools create employment in the long run, but what of those individuals who are displaced temporarily due to the introduction of machine tools? What is going to happen to them?" That is an awkward question, but we must face it. Here are the facts. We quote from a large, well-known manufacturer of power presses.

"I know from specific experience in our own plant that new, modern machines are much more efficient. With one such machine we can frequently do as much work as we formerly did with two or even three obsolete machines of the same type.

"It would therefore seem that the new machines which we buy displace labor. As a matter of fact, with all of the more efficient equipment we have installed, our payroll is just as large as before. We are, however, running a more efficient plant as a result of our investment in new machines. We are handling a greater volume of business and turning out a better product at a lower cost. All of these advantages pass on to our customers and ultimately the final consumer. By buying these new machines we have been the cause of giving additional employment for the labor required in their production.

"If we did not reinvest a material portion of our net earnings in new modern, efficient machines (although the present federal tax system makes it very burdensome to do so), our old obsolete facilities would eventually render it difficult for us to compete. Hence our employment would gradually shrink and we might even reach the point of passing out of the picture, giving no employment at all.

"Therefore, from actual experience and not merely a theoretical point-of-view, I cannot be convinced that machines do ultimately displace any labor."

Automatic polishing machines were installed in a large manufacturing plant. Seemingly they would displace labor. Actually, they so reduced costs on this operation that sales prices were reduced, calling for more business which resulted in increased employment. Many similar instances could be cited, but there still remain places where the introduction of labor saving machinery has definitely thrown men out of work.

As we stated, in 1930 it was only one-third of one percent, but even that is a significant number.

Labor's Viewpoint

President William F. Green of the American Federation of Labor stated on January 4, 1939: "Labor has always believed that the increased production due to technical progress and new industries created by the interplay of such changes can result in greatly increased work opportunities. The Federation does not oppose the introduction of new machine tools nor new processes, but it holds that before changes are made, plans should be made for workers who will be displaced and forced to find new jobs."

He further states, "Consideration has not been given to the displaced workers. Here is an important function for the employment office in cooperation with vocational retraining."

Finally, according to Mr. Green, "We know very little about whether the dis-

placed workers ever find new employment and whether they are forced into new occupations at lower earning rates."

President Green may be right. Industry has neglected these men. Perhaps because of the knowledge that the situation would eventually right itself due to the employment-creating ability of the machine tool. But the situation is serious for the individual displaced. Obviously, a great deal more study must be given to this phase of which we know so little. Here are a few pertinent facts.

Many miners are displaced by the mechanization of the coal mines. Lowered costs of mining were the result of the mechanization but this was not passed on to the consumer, because wages were being simultaneously increased. The net result was that the price of coal increased somewhat, while the demand for coal decreased. Today the conveniences of oil and gas are demonstrating themselves with the result that the demand for coal is receding. Miners are laid off. This result cannot be attributed entirely to mechanization, for mechanization would have undoubtedly led to lower prices, hence greater sales and more employment.

Simple Machines Assist Adaptation to Other Jobs

These miners have been forced to get other jobs and many of them have left their homes and found employment in the rubber industries and in the automotive industries. Today's machines are, on the whole, so simple to operate that a man can learn a new trade in a few hours and these men did so. In many cases their earning power was increased.

Let us again look at facts, not obtained from these abnormal years now passing, but rather from periods where normal prosperity ruled. Let us again question the publication "Machinery, Employment and Purchasing Power." "The amount of long-term unemployment in periods of relative prosperity is very small. People are out of work a few weeks, or in extreme cases a few months. We already have shown that as recently as in 1936 where there was a distinct shortage of men in many trades."

This answer brings us back to William F. Green's statement of policy. We must go ahead with the new machines but we must plan ahead and make provision for the displaced workers.

The president of one of our big steel mills points out that in 1922 the cost of steel at his mill was $102 per ton, but in 1937 this had fallen to $59 per ton. Meanwhile wages and salaries had risen from an average of $1600 per year per worker to an average of $2000 per year per worker. The final result was that there were much increased sales and much more employment.

More Adaptability By Education

The coming of more trades schools, the coming of more manual training courses in our high schools will do much to make our new population more flexible by training and education, so that they can more readily be fitted for different kinds of jobs.

A further thought on this subject is, "Can our factories be made to tie into our agricultural work to a greater extent?" Henry Ford is doing this in several of his plants, where men work a reasonable day at the plant and then spend their after-working, so-called "leisure time" in farming on a small scale. By an extension of this principle, a man laid off could at least make himself a livelihood on his farm land. This is not offered as a necessarily practical solution, but only as a thought to which attention should be given.

TOOL ENGINEERS MUST QUALIFY FOR GREATER RESPONSIBILITIES

By

DON FLATER

WORKS MANAGER, CHRYSLER DIVISION
CHRYSLER CORPORATION

IT IS doubtful whether the Tool Engineer attaches the proper significance to the enormous job of material movement in manufacturing. In most plants very close study is given to proper machines, tooling, and product design that will tend to permit economic manufacture. To give some idea as to the great sum of money spent for handling materials, the following figures are quoted from Automobile Facts, published by the Automobile Manufacturers Association. It is estimated that automobile plants spend one million dollars per hour for material and parts from the raw material to the finished product. Statistics show that over twenty per cent of the payroll in manufacturing industries is for the handling of materials. This is at a rate of approximately $20,000 a minute. The flow of material sent to motor plants has no parallel anywhere in the world, for the motor industry is the largest industrial purchaser in this or any other country. With approximately 15,000 unit parts in an automobile, the importance of having the right piece of material at the right time where the assembly worker can find it accessible when his operation is performed is self-evident.

A shortage of any small part might interfere seriously with the operation of a long assembly line. It is obvious that a study of this phase of manufacturing to see that units are delivered at the many different points, from which it starts over miles of conveyors and ends up at the proper position on the assembly line, almost becomes an engineering job in itself. There are many people who have adopted parts transportation as a specialty in their work and where making proper analysis have been very instrumental in simplifying the handling and transportation of various material.

Functions of Material Moving

These functions might be broken down as follows: 1. Purchasing of raw materials. 2. Scheduling and procuring pre-fabricated materials. 3. Proper scheduling of all materials into the assembly plants. 4. Economic handling and proper dispatching of material to the point of assembly. 5. Line-up of operations to allow the operator to make assemblies or perform other operations at the minimum of physical movement. Therefore, proper flow of unit parts requires the aid of Planning Divisions, Purchasing Divisions, Scheduling, Material Handling and Trucking Divisions, Time Study, and Tool Engineering. Tool Engineers must, in order to properly line up operation sheets, know in advance the shape the material is to be received, the speed of its flow, and the location. When having this information at hand he must then see that equipment, fixtures, etc., are designed and lined up to facilitate assembly or other operations.

Just a Few Years Ago

Everyone can remember back just a few years when it was difficult for a pedestrian to walk easily through a plant, as it often seemed a mass of electric trucks, gas trucks, hand trucks, and other means of conveyance. Today, after careful study, powerized conveyors have eliminated a great portion of this, contributing to much smoother operation in the fabrication of the finished product. The Tool Engineer who has been observing does not need the above facts mentioned to him to realize the importance of making a study of material handling methods and to be somewhat of an authority on them to qualify himself for further responsibilities.

Perhaps the Plant Layout Engineer has somewhat a greater responsibility in unit transportation than that of the Tool Engineer and this fact may come to your mind, causing you to assume this thought, "why should I worry about this when there is another division whose job it is to work it out." But just remember that any responsibility is yours, or at least the knowledge of it, if you are to progress.

Most certainly the Tool Engineer, the Plant Layout Engineer, and the Time Study man should be very closely interwoven in their work to promote efficiency. No one of the three should be at all reluctant to make suggestions for improvement to the others. I believe it important that consideration be given to the advantages of contact with the Product Engineers who design the parts for production and on which the Tool Engineer must provide equipment to machine.

(Continued on Page 84)

MACHINERY, EMPLOYMENT AND *Living Standards*

An address at the Pre-view dinner A.S.T.E. Machine and Tool Progress Exhibition, Convention Hall, Detroit, March 13th, 1939.

By
DR. HAROLD G. MOULTON
PRESIDENT, THE BROOKINGS INSTITUTION

DR. HAROLD G. MOULTON

SINCE the very beginning of scientific discovery and the invention of labor saving machinery men have feared and opposed the use of such productive instruments. Always we find concern expressed not only over the effects of such developments upon employment, but also upon public health and social standards. Moreover, it would seem that our basic ideals and morals are likely to be undermined.

You are all familiar with the destruction of farm machinery in our early history and with the hostility to the introduction of the factory system in England. But perhaps you do not recall the profound concern of Queen Elizabeth over a new contrivance for the spinning of yarn. I am sure you recall that the automobile was a menace alike to the carriage business, to the bicycle, and to the Iron Horse, as well as to civilization; and that the railroad engine in its early days was opposed because it destroyed employment on the stagecoach and the canal boat, while its noxious gases threatened to undermine public health, and kill the birds of the air, the raucous noises meanwhile frightening to death the flocks of the field.

But you perhaps did not realize that quite as great a furor was occasioned by the introduction of the stagecoach, which not only threatened the saddle industry and all its related employments, threatened to reduce government revenues collected from horseback riders at public inns, but also threatened to undermine the health and morality of society. I quote a brief paragraph from a book published in 1673 under the title "The Grand Concern of England":

The English Had Words For It

"Travelling in these Coaches can neither prove advantageous to Men's Health or Business: For, what advantage is it to men's Health, to be called out of their Beds into these Coaches, an hour before day in the morning, to be hurried in them from place to place, till one hour, two, or three within night; insomuch that after sitting all day in the Summer time stifled with heat, and choked with dust; or the Winter time starving and freezing with the cold, or choked with filthy Fogs, they are often brought into their Inns by Torchlight, when it is too late to sit up to get a Supper; and next morning they are forced into the Coach so early, that they can get no Breakfast. What addition is this to men's Health or Business, to ride all day with strangers, ofttimes sick, ancient, diseased Persons or Young Children crying . . . Is it for a Mans Health to travel with tired Jades . . .

"For passage to London being so easie, Gentlemen come to London oftner than they need, and their Ladies either with them, or having the Conveniences of these Coaches, quickly follow them. And when they are there, they must be in the Mode, have all the new Fashions, buy all their Cloaths there and go to Plays, Balls and Treats, where they get such a habit of Jollity, and a love to Gayety and Pleasure, that nothing afterwards in the Countrey will serve them."

Employment Enormously Increased

Whatever may have been the social and moral consequences of technological developments, aggregate employment has been enormously increased. In due course those displaced in particular industries or in given jobs have succeeded in finding employment elsewhere. During modern times the total population has increased much more rapidly than ever before, yet all have found employment. Meanwhile, in the brief time that has elapsed since the industrial revolution, standards of living have been raised more than in all preceding history. These are the concrete results of scientific discovery and their application to the processes of wealth production.

The machine age proper began with the industrial revolution in the last quarter of the eighteenth century, and developed rapidly throughout the nineteenth century. While many factors combined to bring about the phenomenal developments of the nineteenth century, the influence of scientific discoveries and the invention of labor saving devices was of paramount significance. Its relationship to employment and living standards may be gauged by the fact that the population of Great Britain increased from 10.6 millions in 1800 to 37 millions in 1900, while at the same time the standard of living rose approximately fourfold. In the United States the population increased between 1850 and 1930 from 23 millions to 123 millions, and meanwhile the per capita production and per capita income rose from about $250 to approximately $700. (Allowance is made in these figures for changes in the level of prices.)

Science's "Ten Minutes"

If we were to let the span of human history be represented on the face of a clock, the period elapsing up to the last two centuries would be roughly the equivalent of the time from noon to ten minutes before twelve midnight. The last ten minutes would represent the period during which science, engineering, and the system of free business enterprise have been dominant. Economic progress during these last ten minutes has greatly exceeded that of the preceding 710 minutes. The standards of living of the masses today, notwithstanding an extraordinary increase in population, are higher than those of the classes of former times.

The way in which technological improvements and the growth of capital affect employment may be concretely illustrated by reference to the history of a particular business enterprise which has maintained continuous records from 1870 to the present time. In 1870 there were 300 people employed in the company's plants. The working week was 60 hours—10 hours a day for 6 days; and the weekly rate of pay was $9.60. For 48 weeks of work the annual wage was $465. Total sales equalled $1,550 per employee. In 1908, there were 3,000 employees; the working week was still 60 hours; and the annual wage had become $624. During these 40 years there had been very little mechanization in the plant; hence sales volume per employee had increased only from $1,550 to $1,986.

Between 1908 and 1936 more than $30,000,000 was invested in machinery and mechanical equipment in the company's factories. The number of em-

ployees had increased from 3,000 to 7,337; the number of hours had been reduced from 60 to 40; the wage rate increased from 20 cents to 87 cents an hour; and the annual wage from $624 to $1,698. During this same period the wholesale price index had risen only 28 per cent. Meanwhile, sales volume per employee increased from less than $2,000 to $9,175.

145% Employment Increase

Summarizing this story, we find that the installation of $30,000,000 worth of new plant and equipment in a period of 28 years was accompanied by: (1) a 145 per cent increase in the number of employees (2) a 33 1/3 per cent reduction in the number of working hours; and (3) a 112 per cent increase in real wages. Meanwhile, each worker with the aid of the additional capital gave society approximately a fourfold increase in products available for consumption.

Even more convincing evidence of the long-run significance of the improvements of machinery is afforded by the statistics of manufacturing industry as a whole. In the 30-year period from 1899 to 1929 the amount of physical properties in manufacturing industries in the United States increased 314 per cent. During the same period productivity per man-hour increased 142 per cent, real wages per man-hour (with adjustments for price changes) increased 107 per cent, and total wages 216 per cent. The total volume of employment meanwhile increased by 88 per cent.

Looking at this 30-year period from the standpoint of the economic system as a whole—and not merely manufactures—we find that the per capita production increased by approximately 40 per cent, and that at the same time there was an average reduction in the length of the working day of about 13 per cent. It was the development of machinery in its manifold forms that made possible the great increase in productive efficiency. The benefits of this technological progress were taken partly in the form of more leisure resulting from shorter hours; but in large part it was realized in the form of higher standards of living.

Have We Too Much Machinery?

There are many who admit the vast progress which has heretofore resulted from machine industry, but who hold nevertheless that further technological advancements must be halted. They argue that we have reached such an advanced stage of scientific and technological progress that we are menaced with overproduction. They hold further that the primary result of improvements in productive efficiency in the future will be the displacement of labor who can find no employment elsewhere. In consequence, it is argued variously that we must shorten the working week in direct proportion to the increase in productivity or we must arbitrarily restrict the installation of new machinery.

In order that you may not think I am here making an extreme statement, let me quote from a prominent British writer:

"We have now, for the first time in human history, all the material resources and the human skill needed to provide both the necessities and comforts of life to the whole of the world's population; to support, indeed, a population several times as great at standards very much higher than any hitherto known; and to give to every man not only material wealth but the leisure and opportunity which he needs to realize the full potentialities of his nature and enjoy the full heritage of the civilization in which he lives."

I might also quote from an American engineer who has asserted that fifty weeks a year, four days a week, and six hours a day—that is, a 24-hour week and a two weeks' vacation—is adequate to provide the American people with all of their requirements.

Are We at the End of the Road?

What are the facts with respect to productive capacity? In 1929, the year of our greatest production, the total national income—which represents the value of the goods and services produced—was about 81 billion dollars. This is the equivalent of about $660 per capita, or $2,600 per family. Since income was not equally distributed, the great majority of families received very much smaller incomes than this average. Indeed, 12 million families, or 42 per cent of the total number, had incomes of less than $1,500; and 60 per cent of the families had less than $2,000. At 1929 prices a family income of $2,000 was sufficient to supply little more than the basic necessities required for health and efficiency; generally speaking, it provided no margin for comforts and luxuries of life. Budgetary studies indicate that the provision of "reasonable standards of living" would require an income nearly double that enjoyed by the masses of the American people in the year of our greatest production.

We were not, however, making full use of our existing productive facilities. The comprehensive investigation of America's productive capacity recently made by the Brookings Institution* indicated that we might have produced in 1929 something like 20 per cent more than we did produce. It is true, to be sure, that much scientific knowledge then available remained to be translated into actual producing power. Hence our potential productive capacity was somewhat greater than these estimates would indicate.

Production Curtailed—Population Increased

In the years that have elapsed since 1929 there has been an actual curtailment of national productive capacity, while at the same time we have had a further increase of population of more than 7 per cent. Per capita production in 1937 was only about 85 per cent as great as in 1929. The reduction in productive capacity during the course of the depression years is simply the result of our failure to make good the actual deterioration of plant and equipment that has occurred.

The production task before the people of this country at the present time may be stated in the following terms: First, to make good the actual deterioration of plant and equipment sustained during the depression; second, to increase productive capital in proportion to the growth of population that has occurred; and, third, to expand the output of consumption goods in accordance with this growth of population.

It is of interest to note for purposes of comparison that fifty years ago similar fears were expressed with respect to the great increase in productive capacity. In the middle eighties an eminent economist, David A. Wells, attributed the great depressions of trade in the seventies and eighties to the fact that "the supply of the great articles and instrumentalities of the world's use and commerce has increased, during the last ten or fifteen years, in a far greater ratio than the contemporaneous increase in the world's population, or of its immediate consuming capacity." Carroll D. Wright, in an official government report in the late eighties expressed a similar concern over the lack of investment opportunities and employment possibilities.

In the ensuing forty years nevertheless we underwent the greatest period of technological progress and industrial expansion in our history. There is no more reason for assuming in the late 1930's that we have reached the end of industrial progress than there was for the assumption in the late 1880's. So long as the great masses of our people have vast unfulfilled desires we should obviously continue to increase productive efficiency as the only means of raising standards of living.

Is There Room for Expansion?

We must, however, consider still another argument in support of the view that the era of industrial expansion has ended and that progress in the future must of necessity be at a very much slower rate than in the past. A number of forces and considerations lie behind this point of view, among which the following deserve mention: (1) The disappearance of the frontier; (2) the substantial completion of the building of our great industries, with no significant new ones in sight; and (3) the declining rate of population growth forecasting a stationary population in the not distant future. The severe and persistent character of the great depression which began in 1929 is also regarded as evidence that fundamental changes in the American economic scene have already occurred. This point of view is perhaps a natural outgrowth of the prevailing character of American economic development over the course of the last century.

We had vast unsettled areas and un-

* "America's Capacity to Produce," published by the Brookings Institution.

exploited resources; we had a rapidly expanding population resulting both from the birth rate and immigration; and we built a never ending series of new industries—railroads, public utilities, and manufacturing enterprises of every description. In the light of this history, and of the recent period of stagnation, it is easy to understand how it might appear on first thought that our future, so to speak, lies behind us.

A factor of vital importance has, however, been overlooked in this line of reasoning. Before looking forward, let us look backward for a moment and examine the sources of expansion in the past. Economic activity—the use of our labor power and our capital equipment—has always been directed to a double purpose: (1) the production of goods to care for the primary needs of increasing numbers of people; and (2) the production of increasing quantities of goods for the existing population. Stating the matter in individual terms, we seek not only to produce enough to provide our children with necessities, but we hope to enable them, as well as ourselves, to achieve higher standards of living than were enjoyed by our forebears.

Per Capita Income Rises With Per Capita Production

We may translate these general statements into specific terms by reference to what actually occurred in the great era of expansion from 1900 to 1929. We did, it is true, devote our energies to the production of primary goods and services for a steadily expanding total population (do not forget that the new population were producers as well as consumers); but at the same time we were constantly producing more for the already existing population. In the course of this thirty-year period as a whole per capita production, and with it per capita income, rose almost 40 per cent.

Is it not obvious that a cessation of population growth does not render it necessary for us to refrain henceforth from producing more and yet more for the existing population? Are not the unfilled wants and unsatisfied desires of the present 130 millions of people just as real a source of potential demand as the elemental needs of those who might be born in the years ahead? The character of our productive output might differ in considerable degree, but the total output need not be affected—that is, not until our desires are fully satiated. Our studies indicate that we need have no concern on this score until the national income is at least three times its present level. We have been accustomed to thinking of expansion in terms of frontiers, geographic areas, and numbers of people—that is, in extensive rather than intensive terms. Hence we are prone to overlook the vast potential markets that may be opened on the intensive frontier of development.

If we are to expand this frontier and realize progressively higher standards of living—and, in the process, furnish increasing employment for both labor and capital—we must of course operate the economic system on the basis of certain clearly defined principles. In brief, we must so operate the system that the real purchasing power of the masses of the people will continuously expand in proportion to the expansion of producing power resulting from technological progress. The problems here involved will be elaborated in later paragraphs.

Must Government Enterprise Supplant Private Enterprise?

The great depression of the early thirties, and our failure in the recovery period which followed, to return to former levels of production and to absorb unemployment has led many to the conclusion that the system of private enterprise has outlived its usefulness, or at least demonstrated that it must be supplemented by a continuous expansion of public enterprise. The government, it is urged, must take up the slack which private enterprise is unable to eliminate. This thought is closely related to the conception which we have just been considering namely, that the era of capitalistic expansion is over; and it also helps to explain the view that public expenditures should henceforth be regarded as a form of investment.

Is Government Spending a Form of Investment?

The assumption that private investment and capital expansion cannot longer be relied upon to provide expanding employment and national income underlies the present government spending program. Originally, the expansion of government expenditures was conceived as a device which would increase the flow of money through consumptive channels and thereby not only provide essential relief but also stimulate the expansion of private capital enterprise. The new theory—which fortunately is not held by all government officials—is that government spending is a necessary supplement to private enterprise. It is argued that inasmuch as government deficits serve to build up national assets they involve no financial dangers. They are simply public investments as distinguished from private investments.

The validity of the conception that government expenditures are really investments may be readily tested by analyzing the character of government disbursements. The latest estimate of total expenditures for 1939 is about 9.6 billion dollars. Interest, veterans' pensions, national defense, and civil departments and agencies account for 3,360 millions; outlays for relief and agricultural aid aggregate 3,346 millions; and public works and aids to home owners, 1,555 millions. The balance of about 1.3 billions is represented by social security and miscellaneous outlays.

The interest and pension obligations, we may readily agree, are hardly assets. Expenditures for relief and agricultural aid do not result in an increase in tangible wealth; indeed, the latter represents rewards for restricting output. Expenditures for the civil departments, however essential from the standpoint of public welfare, clearly do not directly increase the nation's physical properties. Some of the military expenditures and the outlays for public works and for assistance to home owners do directly increase the tangible property of the country, but they are not usually revenue producing properties.

Governmental Expenditures Do Not Produce Capital Assets

The government's excess expenditures have in the main gone for consumptive purposes which, whatever indirect benefits they may yield, do not produce capital assets. Moreover, even the public works which have been constructed are not as a rule assets from which the government may expect to derive revenues out of which the investment may be liquidated.

In a word, what has been happening is that we have been constantly increasing the public debt and the amount of taxes to be collected, without increasing the tax-revenue-yielding properties of the country. In consequence, the burden of taxation upon private enterprises and the general public grows constantly heavier. Only if the government were to embark in a wholesale manner upon the building of railways, public utilities, houses, or manufacturing establishments, from which dividends might be obtained—in enterprises which yield revenues—might government outlays properly be regarded as a form of investment.

Right here we find one of the major explanations of the hesitancy of private enterprise to assume the risks of expansion. A constantly increasing burden of taxes—without assurance that fiscal and monetary stability will be permanently maintained — not only dulls incentive, but occasions risks too great to be assumed, especially in the field of capital investment. This is precisely where the greatest degree of unemployment exists. Other factors which contribute to the persistent state of uncertainty are too well known to require mention here.

In the light of these factors it seems obvious that the system of private enterprise has not been proved incapable of promoting further progress. Before that can be definitely shown, it will first be necessary for us to have a period of genuine cooperation, rather than open or covert antagonism between government and private business. The reestablishment of confidence is the first requirement for any program of genuine recovery and expansion.

Interrelations of Science, Technology, Business Organization, and Economics

Scientists, inventors, engineers, business managers, and professional stu-

dents of economics and government are in final analysis concerned with a common problem—that of increasing the capacity of mankind to satisfy their wants. Progress toward higher standards of living results from combined effects and influences of scientific discoveries, inventions, engineering applications to productive processes, business organization and policies, economic institutions and government policies.

Experience conclusively shows that the utilization of new knowledge and inventions in increasing productive efficiency is not an automatic process. It can be seriously retarded by unsound business policies, by maladjustments in the general economic system, and by government policies affecting both business management and the operation of the economic system.

Accordingly all groups represented at a meeting such as this must study the great problem with which we are concerned in the broadest possible way. The economist, if he is to be helpful, must be conversant not only with abstract economic principles and processes and with sources of statistical information; he must also be thoroughly familiar with what is going on in the field of industry both with respect to scientific and engineering developments and business policies as they relate to and affect the operation of the economic system. Those engaged in the practical operations of business are commonly so immersed in the every-day practical problems pertaining to their company or industry that they do not have the opportunity to study some of the implications of the fundamental problem with which we are here concerned.

On the other side, economists all too frequently lack the intimate contacts which are essential if their investigations are to be realistic, penetrating, and constructively useful. Not only are such contacts essential to the development of our knowledge, but they are also necessary if the results of our inquiries are to be of practical service. One of the great needs of our time is the holding of systematic conferences between engineering and industrial groups on the one side and professional students of economics and government on the other.

The Essential Principles

I have already referred to the necessity of operating the economic system in accordance with certain essential principles. These must now be briefly elaborated.

New scientific discoveries and inventions are applied to the processes of wealth production through the medium of engineering. The engineer does his work in conjunction with a business enterprise which must appraise the feasibility of the development in terms of profit and loss. The individual business enterprise in turn is a part of a complex economic system, the successful functioning of which depends upon the utilization of certain mechanisms or principles.

The engineering conception is direct and fundamentally simple. It is based upon the elementary assumption that the function of engineering is to apply the new knowledge that is continuously accumulating to the improvement of productive instruments and processes, with a view to increasing the efficiency of mankind in adapting natural resources to the satisfaction of human wants. Increasing efficiency simply means producing more with the same effort—in consequence of which standards of living will be raised.

If it be agreed that the engineering conception of progress is indubitably true, then it must follow that the test of an economic system is to be gauged by its efficiency in promoting the engineering ideal. The system of private business enterprise, as it has often been expounded by both professional economists and business leaders, does in fact embody this engineering conception of progress. The nature of the problem is, however, complicated by the fact that under the capitalistic system production is financially organized and controlled.

Financial Organization and Control

Business managers use money in the hiring of Labor and in the purchase of materials and supplies, and they sell their products for money. The aggregate amount of money received from sales must of course exceed the aggregate disbursements if profits are to be realized. Thus business has its setting in a structure of monetary costs, prices, and profits; and the economic requirements for progress must accordingly be analyzed in these terms. The incentives and mechanisms by which the competitive system has been supposed to insure rapid economic progress and higher standards of living may be briefly summarized as follows:

First, it is contended that each business manager naturally stands to gain by increasing efficiency and thereby reducing costs. He may accomplish this by the construction of a larger and more efficient plant, by the installation of better equipment, by the introduction of superior internal management, by improved methods of marketing, by integrating various stages in the productive process, or by a combination of various methods.

Second, having reduced costs of production he is in a position to increase his profits in one or another of two ways: He may continue to sell at the same price as before, enjoying the advantage of a wider margin between cost and selling price, or he may expand the volume of his business by means of price concessions. It was reasoned that since the increase in efficiency which is responsible for the reduction in costs commonly involved an expansion of productive capacity, and since the maximum economies can be obtained when operating at full capacity, the greatest profits will result if sales are expanded by means of a reduction of prices. In short, increased efficiency makes possible lower prices, while the profit incentive was held to insure an actual reduction of prices.

Third, the process naturally involves the continuous elimination of obsolescent or otherwise inefficient high-cost establishments. The industrially fit, as gauged by ability to sell at a minimum price, alone survive; moreover, the efficient of today promptly become the inefficient of tomorrow. A particular businessman, firm, or corporation may indeed survive over a long period of years, but only if the production methods employed keep always abreast of changing times. It will be seen that with the system thus operating standards of living would steadily rise. The progressive reduction of prices as efficiency increases would, of course, constantly increase the purchasing power of the masses—giving them an increasing volume of goods for the same money.

True Cost Reduction Results from Increased Efficiency, Not Lowered Wages

It should be carefully noted that this theory of progress implies that the reduction in money costs must result from increased efficiency rather than by a mere reduction in money wage rates. A reduction in wage rates may indeed lower money costs and prices; but since it neither increases efficiency nor the purchasing power of the masses, there is no resulting economic advancement.

In order to reveal more distinctly what is involved in raising living standards in a pecuniary society, I would lay down two principles as follows:

First, the process of raising the standard of living of wage earners necessarily involves increasing the spread between wage rates and prices. That is, a wage earner can increase the volume of his purchases from year to year only if wage rates are increased relatively to the prices of the commodities which he buys. If he gets more dollars and prices remain unchanged his purchasing power is expanded; if he gets the same number of dollars and prices decline, his purchasing power is expanded. It cannot be expanded, however, unless the spread between wages and prices is increased.

Second, an increasing spread between wage rates and prices depends fundamentally upon increasing the efficiency of production. While minor and temporary increases in wages may sometimes be achieved by trenching upon profits, a progressive increase in the wage price ratio depends directly upon the acceleration of technical advancement, improved management, increased labor efficiency, etc. Any practices or policies that tend to work in this direction are economically sound; and those that work in the opposite direction are economically unsound.

The Road to Progress

In conclusion I would summarize the fundamental requirements for sustained progress in the following terms:

There must be constantly increasing efficiency in production on the part of both labor and capital. Only by everlastingly improving technical processes and lowering the costs of production can we obtain progressively higher standards of living. To try to accomplish this result in any other way means simply tugging in vain at our collective boot straps.

As efficiency is increased, the benefits must be broadly disseminated among the masses by means of high wages, low prices, or a combination thereof. This is essential for a double reason:

First, it is a fundamental requirement for social and political stability and the well-rounded growth of a democracy. It is doubtful indeed if any economic or political system can permanently maintain itself unless it does maintain the goal of the greatest good for the greatest number.

Second, a broad dissemination of the benefits of technical progress is necessary to provide the market demands for an expanding industry. Under our capitalistic system we produce to sell goods in the market. If we increase capacity to produce without correspondingly increasing the capacity of the masses to purchase, we simply reach an impasse. Production schedules have to be restrained, with an accompanying retardation of the rate of economic progress. Industrial growth, development, progress, require the expansion of consuming power step by step with the expansion of producing power. To put the matter in the simplest possible terms: Growth in the economic organism like growth in any other organism must proceed from the deepest and broadest possible rootage. It must rest on the expanding well-being of the entire population.

The Trend to Hydraulics

By

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The trend in machine and tool development is definitely toward hydraulics, nor can this statement be charged to bias or partisanship since, in the first place, the field is open to almost anyone, and in the second, hydraulic power is not universally applicable. There will always be a field for the purely "mechanical" machine, and compressed air will have its uses as long as people work with tools and machinery. And long after that, no doubt. It is significant, however, that makers of pneumatic equipment are branching out into hydraulics; the most now furnish hydraulic cylinders and valves, although pumps and "boosters" are confined to a smaller group of manufacturers. Nor, unless one goes into high pressure, as in cold riveting and kindred operations, is there much choice between makes. They're all good, and prices are comparable, so it boils down to personal preference and the particular salesman one likes. Assuming, that is, that you want the simpler equipment; when it comes to involved applications consult the engineer who knows his stuff.

There is, too, the consideration of replaceals and spares, which may make it desirable to stick to one particular make as a means of reducing inventory. That is one phase of standardization which may deter users of one make from changing, although, where a maker comes out with a patently superior unit, change is the better policy. Standardization should not be a barrier to progress. In cases where a change is being made from pneumatic or mechanical equipment to hydraulic, it may be well to proceed slowly, thoroughly investigating various makes before deciding. Especially should future requirements be considered, with a view toward insuring ample power and capacity. In this connection it is almost axiomatic that a maker whose product compares favorably with the best, or which is superior, will constantly improve, either leading or keeping pace with developments.

There is nothing partciularly new or novel about hydraulics. It is like weights and measure; the Assyrians and Egyptians had them millennia ago, but it is only in this modern age that we have refined to milligrams and millionths of an inch—and maybe finer. An old application was the hydraulic ram, used to raise water to higher levels, and fifty years ago or more the hydraulic elevator served the "sky-scrapers" of five or six stories. And the hydraulic jack was in use when the writer was wishing for the mythical "putting on machine," which, incidentally, has since become reality. We put on stock, these days, by welding.

The writer believes that he is one of the pioneers in modern hydraulic design since, some twenty years ago, he designed a hydraulic feed as substitute for hand and mechanical in a rotary swaging machine, one of the largest if not the largest built up to that time. Then, however, we used water at city pressure, the cylinders being made large enough for the required load. The "trial horse," which both the boss and the customer regarded askance, worked so well that a repeat order was placed for six more machines. The boss did not look askance at that. Nowadays, we have hydraulic cylinders operating, with remarkable efficiency and reliability, not to mention economy, at pressures well over 5000 lb. p.s.i. A 2½" cylinder, under direct pressure, exerts a thrust well in excess of twelve tons, is almost instantaneous in operation.

Among the advantages of hydraulics is high power with small compass, an essential feature, for instance, in riveted assemblies where accessibility is limited and room at a premium. With balancers and overhead trolleys, the hydraulic (and air) riveters are far superior to presses, besides having the added and, as a balm to jangled nerves, quite essential feature of silence. While air powered riveters are used to a considerable extent—in fact, air was the first stage in the evolution of the portable riveter—they must be supplemented with toggles to build up pressure, else the large cylinders render them too bulky for efficient use. It is only fair to add here, however, that for smaller rivets—say ¼" or less—the air operated tools are light, convenient and entirely suited to the job. Especially are they applicable where a single compressor is preferable to a power unit for each tool. I am, here, discussing a trend, deal with facts rather than personal preferences.

A hydraulic press, while the works are "buried" as deep as the mechanical, requires but a fraction of the head room, an important consideration when overhead cranes are used or when low roofs are factors in selection of equipment. And the hydraulic press is silence itself compared to the geared crank or toggle press. And while I haven't, personally, seen such a machine, it should be entirely practical to design and build compound presses (comparable to toggle) with even an extra movement or two, as several rams. Why not?—for God and the Tool Engineer nothing is impossible.

Hydraulic development is in its infancy, yet, it is entirely within the bounds of conservatism to say that it is revolutionizing mass manufacture. Several leading manufacturers of machine tools have developed hydraulic feeds, traverses and lifts to a point of efficiency that make them superior, for manufacturing purposes, to the conventional motions previously used. Feeds can be regulated from 0 to ultimate without other screws or gearing than is incorporated in the pumps, and such feeds are positive and chatterless. If not already engineered, we may soon see hydraulic clutches and transmissions in machine tools, promoting silence and efficiency. Then, in time, will come development to insure positive, recurring cycles in automatic machinery.

What is probably a record attendance at any technical society's annual banquet is pictured for you above. The attendance, only a portion of which is shown, ran more than six hundred Tool Engineers and their guests. The scene is the grand ball room of the Book-Cadillac Hotel in Detroit, March 16th, 1939. William (Bill) Stout was the featured speaker.

CHOOSING the PROPER ASSUMPTIONS

AN ADDRESS BY WILLIAM G. STOUT AT A.S.T.E. ANNUAL DINNER, MARCH 16, 1939

A FEW years ago we had an SAE machine exhibit in the other banquet room. And someone there had a pump system for Diesels—little pumps —and the salesman had one of these little plungers on display and was explaining to the crowd that this was the most perfect manufacturing anywhere. "This thing is an absolutely accurate piece of work." In front of him in the crowd was a man with an ear trumpet. "What did you say?" he said.

The salesman repeated. "Let me see that," said the questioner. He took something out of his pocket, measured the plunger and handed it back. "It is 4 millionths of an inch small on one end," said he.

You do not need to laugh at that either because they celebrated that man's birthday recently (see page 40, this issue) and any of you using the "Jo blocks" know that it was Johannson himself. When he said it was 4 millionths small at one end, he meant just that.

I remember he came to the roundtable one noon at Fords, very pleased. He had piled 17 of these blocks one on top of the other measured them up and they were only 12 millionths off—which is fairly accurate.

In our industry we call that accuracy. In astronomy that would be like using a 3 ft. rule. Take the grinding of a lens such as they are doing out west. If you had a millionth of an inch off that would be about a thousand miles off way out where they are going to look, so they have to be more accurate than that and they measure the change in size of that lens so closely that they tell you when a man walks within 30 feet of it the expansion that comes from the heat of his body. They work the final stage with a man rubbing the lens with his thumb under water, so you can see how much glass you would rub off with your thumb just once or twice. That is the accuracy on that side.

One other to illustrate the opposite might be that of James Watt at the time he was making the first steam engine. He had to make a cylinder that was about 6 feet long and 2 feet in diameter. They developed a lathe and finally his brother wrote him from Glasgow that their machine worked and they had "come practically to a point of absolute accuracy" because he said "the diameter of this cylinder from one end to the other doesn't vary more than the thickness of a ha'penny."

That was accuracy in those days: an accuracy assumption.

Choosing Proper Assumption

You will find that all thinking, is the ability to choose the proper assumptions from which reason and analysis must spread. If I gave you a certain set of assumptions, probably 90 percent of you in the room would wind up with the same solution to the problem. The assumptions are what make the thinking important. When we get an industry established and when we finally train our engineers in that industry up to assumptions that were established long before we very often freeze that industry into a line of tradition which does not enable it to progress. One

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CONVENTION SAYINGS WORTH REMEMBERING

" . . . (the Tool Engineer) . . . is the cutting edge in the frontier of economic development."—Dr. Harold G. Moulton.

" . . . for every invention heralded by the public . . . there are probably 1,000 inventions in tooling and machines which are necessary to bring that invention within reach of the public."—William B. Stout.

" . . . as long as there are still people in this country who do not have the things they want, productive capacity should be increased." —Dr. Harold G. Moulton.

" . . . the world moves so fast that by the time a new machine is developed to make some article, that article is already obsolete . . . When you develop machines, make them flexible so they may also be used tomorrow."—William B. Stout.

" . . . Last year we had 1500 members and 17 chapters. We elected Walter Wagner and got 3,000 members and 24 chapters."—L. Clayton Hill.

" . . . the machine is the final product. It creates nothing. The tool is the creator."—Professor John Younger.

" . . . the ingenuity of man has never failed to solve a problem, once that problem has been definitely stated."—James R. Weaver.

example of that might be the railroads which started before the days of research. They started before the days of real engineering. Built and developed more or less on a cut-and-try process. No heat treating originally. No alloy steels. Just ordinary materials, garden variety, and the railroad grew by the cut-and-try method. Certain things became established as facts. And once they were established as facts the industry froze into a jell and has gone just like that ever since. Now we are getting research back into the railroads and will begin before long to see a very great change in every angle of railroading that politics will allow.

All of our progress along engineering lines has come from ideas that start new assumptions of progress. Not all of those ideas are highly technical. If you designed today a steam turbine or attempted to design something as scientific as that you have months after months of mathematics and a tremendous amount of analysis and testing of materials before you get one running and the firm that makes it might go broke before they get through. They are taking a terrific gamble.

On the other hand along comes somebody smarter who has no technical education and he invents a new kind of safety pin and switch or something and he makes a lot of money. We have built some of these rear engined cars. We haven't made any money at it yet, but the toy companies started making some and they made 20,000 of them as toys and made some money. Maybe we should have been in the toy business. I don't know.

The other day I saw a new kind of electric switch, it would make you laugh when you hear of it. There isn't a man in this room who couldn't have invented it. There is nothing in your education that would have prevented you from doing the same thing. You have often taken two copper tubes and put a hose around them to make a connection in your car, or something of that kind. You never thought of doing that for an electrical switch. This chap took two wires and put a rubber hose around them and filled the hose with mercury and, if you want to break your contact just squeeze the rubber hose. No arcing, no lots of things. Practically a perfect switch and it works and he is really going to town.

A lot of times you take the engineering that you have been doing and in a sense turn it over on its back like a turtle with another viewpoint. Start your assumptions from a different viewpoint and you find new engineering comes along. Originally all automobiles had the engine in back. Back of the seat just like a buggy, the only space in a buggy to put an engine was in back so they put it back there and, of course, before long they found it was a tremendous problem to try to drive a rear axle and a lot of other things and it was much better to put the engine up front and run a shaft back and there it has been ever since. Well, somebody came along and began to really study the thing and finally the bus companies woke up and tried putting the engine in the rear. When you put the engine in back you let the engines take the bumps instead of the passengers, you take the weight off the front wheels so they don't bury in the mud when you go off on the soft shoulder, and you help your tire situation a lot. Today I think there is no bus company left that is not making rear engine busses.

On trucks, you can't do it. Your loading problem is different so that is something else. You will see motor cars go the same way, however, very shortly.

Production

Now from the engineer's standpoint, you come into the business that you people are connected with, the production end. Suppose I get up a design for more perfect this, or that, say an automobile. It costs $100,000 to make one. You can see right away we are not going to create any wealth with that because nobody can afford to buy one. Somebody has said that if we built any of these low priced cars today by hand one of them would cost around $25,000 to build, and it won't be as nearly as good a car.

The basis of all our work when all is said and done is to create wealth. I don't mean by that, money. Wealth as represented by the average living conditions of every one of the community. Wealth is something human that goes into a people and the creation of wealth is the creation of that something that leads to the growth of that community. Our old idea of wealth was that of riches. Well, there is a lot of riches in the world. Over in India some of these maharajahs have more money than Henry Ford. It is buried down in the ground as sapphires and other things. They say that it is just as valuable in there as if they brought it out. When they need any money they do like Desert Scotty out in Death Valley, just go out and get some more gold for their needs.

That is riches but it is not wealth.

It only helps the man who owns that riches.

It does not distribute.

There is no distribution of wealth to the people. The first fundamental of the creation of wealth is "desire." I think the Bible says 'Thou shalt not covet.' Yet desire to own is the basis of all industry. Somebody has something and somebody else wants it and the more you make them want it the more chance you have to build up business and the living conditions and wealth of the community.

In the early days of the railroad in Africa they tried to get the native tribes to work on the railroad. They went to the chiefs and told them what they wanted and said that they would pay them "money." "Money," they asked: "What is that?"

'That is something you can take and buy whatever you want.'

'We don't want anything.'

So they didn't want anything and there was no such thing as money and there couldn't be anything such as money. After a while some man for some reason or other happened to come in on a bicycle and these chiefs saw the bicycle and wanted it. Today in the middle of African jungle you may run across some fellow in the long robes riding on a bicycle and the British said that at last they had something to get these fellows to buy, and they will come and work on the railroad. They offered them a bicycle for so much money. Instead of coming to them, they put a couple more wives to work in the field and took what they earned and bought a bicycle; so finally the railroad had to be built with labor plus fear which is largely the way that those people still have to be handled in their native haunts.

Distribution

And so there can be no wealth created for a community where there is no desire so a certain covetousness is the reverse of what our assumptions have been to date.

On the other hand, say a man gets up a new idea. Our immediate aim is to get that device to every possible person that we can possibly reach for his own betterment and for our profit. You can't reach all of the public. Sixty per cent of the public get less than $1500 a year. You cannot reach them with a $5,000 article, if you are going to get to the average man who in the early days had less than $500 a year, but in this country we are very much richer than any other nation in the world. Fifteen hundred dollars a year is the income of 60% of the population. So we have to produce something they can buy, if we make it by hand they can't buy it. So you fellows come in and develop production methods that take care of large quantities of duplicate processes and operations. A man doing a thing over and over in the old way was more a slave than he ever would be on a machine.

Suppose you had men in your shop hammering out hub caps all day long by hand. They would be far greater slaves than they would be running a press. And so we make the machine to save the labor and save the slavery and increase their earning capacity.

In the transportation end, which is 85% of all industry, suppose you knew someone who was able-bodied and strong and willing, and wanted to earn some money. He came to you and offered to carry a suitcase from here to Toledo if you would let him do it because you needed the suitcase shipped and he would carry it over for you. You probably would pay 25c to ship it. Suppose you would pay a dollar. Well, he could walk over and carry it on his back. He couldn't possibly earn 25c a

day carrying a load on his back. Along comes some "economic royalist with a surplus" and buys a truck, and this truck he presents to the man who is willing to work. He not only presents that but he presents him with a load in both directions and a schedule and the man gets on the truck and it is all he has to do, just drive and steer the darn thing and he can earn his $6 a day or whatever he gets.

You don't just pay it to him. He has to earn it or you couldn't pay it and he plus the machine earns that amount.

A carpenter with a hammer and saw can earn a certain amount per day. A man with a hammer and saw demands the same wages that the man demands who runs a $50,000 press gets and we have to pay it to him: The price of housing goes up, where the working man has to live in either a slum or trailer; and so there is a problem of production that must be met in a way so man can substitute for a mere hammer and saw a machine that can help do his work, so that he can actually earn the wages instead of just being paid the wages.

The average factory today spends about $8,000 per workman for investment and that $8,000 is put there to do the work for the man who merely takes care of it. He goes ahead with that process and as he does that and has been doing it and as you fellows have been furnishing him machines a very great change has come to this country.

Invention

We are inclined in a publicity way to look on the inventor as a very colorful chap who gets up this and that idea, but I imagine for every one invention that got a reputation in that way there have been a thousand in your industry that go unheralded and the man who invented them is just one of the gang. You fellows are so used to getting up new tools and new ideas you don't even class as great and romantic, inventions that after all have been vastly more colorful in the tooling of the production goods than in the invention and development of the machines themselves.

Now anyone here could invent a safety pin. The safety pin is simple enough so there is nothing to that, but how many men in this country could design a machine that could turn out the safety pins by the millions as they are turned out, and with the accuracy and low cost with which they are produced.

Those machines are of vastly greater importance after the first machine is invented than the first invention itself.

We made the automobiles and they ran but the machines that have produced the automobiles and their parts have been the real achievement that has made the motor car possible in the distribution of its wealth to all of the people.

Two Stages—Three Factors

And so we have gone through two stages of a cycle of our present civilization. First, the invention of an idea. Then the invention of production machinery to produce that. 1 The idea, 2 production, and then 3 comes in a law which has just hit us in this generation and which is the basic fundamental of our present-day civilization that must be most closely watched and that is "obsolescence." Three factors, 1 creation of the idea, 2 production, 3 obsolesence; and then you go back and create a new idea and the cycle keeps rolling because no matter what you are working on today, whether it is in the tool business, automobile business, silk business, drug business, or architecture, or anything else, your own industry is going to be revolutionized in the next 5 years. There isn't a thing that is being used in this room right now that isn't more or less obsolete. New types of lights coming. This whole material here is not modern. The shape of this room acoustically is not right. Your walls are not made of the proper acoustic material. This microphone will be twice as good two or three years from now as this one is. In fact they have some on the market now that are very much better than this. They cost a lot more money too. Now in some of these they have found, I think, the best use for Epsom salts that has ever been found and that is in this microphone. It is good for talking any way.

But each one of these things we are working on gets obsolete as research carries on our knowledge to new points. Let me visualize a few things that are coming along.

For example we think of clothing as being something permanent; that we are always going to raise sheep and have the wool and make cloth and weave it on looms, etc. Well, we have rayon fabrics that we developed by study of the methods by which the cockroach digests his meal of cellulose in its tummy. From that came the rayon industry. We have developed rayon silk that is better than real silk. We have developed leather that is better than real leather. We have developed rubber that is much better than real rubber for many purposes and very shortly we expect to see synthetic rubber replacing the natural rubber.

Rubber in Production

Speaking of rubber in your production business, I was out in one of the airplane plants in California and saw a big press with a bed I would say guessing, about 10 ft. square, maybe more, an enormous big thing with 3,000 tons pressure and using this rubber for cutting out metal parts for airplanes, forming pieces for tanks, flight parts. The top of the press was a great big block of rubber. Well, they put a big steel template on the bottom and put a piece of dural over it and bring the rubber down and shear the metal off in whatever shape they cut this piece out below and form pieces of 3 or 4 inches depth. When I got back to the plant office I said to Donald Douglas: 'How long does that rubber last? It seems to me that that is a lot of punishment.'

He said: 'What did it look like?'

'It looks as though you put it on last night. It looks as though it were a new block.'

'That has been on there for 4 months, working 24 hours a day and it is the same piece of rubber.'

'Maybe there is something there.

Now there are a lot of such things in tooling production. Your assumptions here are vastly different than the assumptions in Los Angeles in the airplane business. If I should say you would get a contract for 200 pieces you wouldn't call that production, but if we get a contract for 200 airplanes that is pretty darn good. So they started out making 250 pieces and you can't do that by building a $250,000 die so they developed the technique of zinc and lead dies, rubber stuff and hydraulic shaping processes and things that will do for small quantity stuff. In other places they think in tremendous terms of quantity and probably the first ones to reproduce a lot of things all the same quantity were the printers and now we are beginning to stamp out and make parts the same way.

Tooling vs. Obsolescence

And so things go along and we study first the original idea then the tooling or instrumentation and finally the obsolescence factor. There is one industry that goes through all three of those and that is the business of research and, if there is any one foundation for all of our future in this country and in other countries, if there is anyone stabilizing element that will solve all the political problems, as we will eventually, it is that of research. We have proved that perhaps in this country more in the chemical industry than almost anywhere else.

Talking the other day with some automobile men I made the statement that there had been no improvement in the motor car in the last ten years except in accessories. There has been tremendous improvement in the tooling and costs and the number of chromium parts, but not so much improvement in the car itself. In the meanwhile during this same period and with no engineering background to begin with the airplane has come up from an average cruising speed of 90 miles an hour to a cruising speed of 400 miles an hour. It has jumped from a 200 horsepower maximum, air-cooled, to 2,000. It has gone down to a weight of 1½ lbs. per horsepower, whereas the automobile engines are still 10 lbs. per horsepower, the same as they were 12 years ago.

We now can travel 5,000 miles without landing whereas 10 years ago it was probably 600 miles. We make our machines of metal whereas they were formerly of wood, with the pilots outside. Now a man couldn't stick his head outside as the air would pull the top of his head off. We have controlled landing of the airplane so that instead

A SYMPOSIUM ON MECHANICAL SURFACE FINISH

March 15, 1939, Convention Hall, Detroit

Chairman: C. J. OXFORD

CHIEF ENGINEER
NATIONAL TWIST DRILL AND TOOL COMPANY

Introduction and General Discussion by J. R. WEAVER, Director Equipment, Inspection and Tests, Westinghouse Electric & Mfg. Company

The dictionary says smoothness is "not rough." When we look for roughness, we find it means "not smooth." How to define the word "smooth" so that we all have the same understanding is a problem. What is that quality which we call "smoothness"? How smooth is smooth? Does lustre affect our physical conception of smoothness? That is, does a lustrous surface look smoother to the unaided eye than a similar surface which is not lustrous? It is important to decide this point definitely for most surfaces will be judged by the unaided eye. It is quicker than any instrument. We will use an instrument only on those surfaces of which we are suspicious or which look to be on the doubtful side. Therefore, it is necessary to know how a smooth surface looks; what its characteristics are aside from its light-reflecting or dispersing qualities.

This brings up another point. Assume two surfaces of the same quality or smoothness, one finished by grinding so that serrations run parallel to each other and the other finished by lapping or superfinishing, so that the serrations run in whirls; which of the two surfaces looks smoother?

Linear Dimensions Are Criterion

Machining operations finish to linear dimensions. A shaft is so many feet long, a journal so many inches in diameter. But what of the quality of the surface of that journal? If it is rough machined it is rougher than if it is ground, but we are able to achieve an infinite number of degrees of smoothness by grinding. Therefore, we cannot describe a surface by naming the method of producing it. The method of producing a surface must be only a means to an end. The surface quality desired must be the end. The designation of the quality of the surface, the scale used for comparing two or more surfaces of different qualities, must be, preferably, an absolute measurement, such as the inch. I am afraid that our visual conception of surface quality, as judged by the unaided eye, always will remain subject to the personal element, and in any standardization procedure, it is always desirable to eliminate the personal element.

Whatever definition of surface quality we adopt must be universally applicable to all surfaces regardless of how the surfaces are produced. Such a universal definition would enable us to produce the required surface by the most economical method. We might be satisfied with fine turning; we might add a grinding operation; or we might go to honing, lapping, or "superfinish." It should not be necessary to use all these operations, and it may not be necessary to use any of them. If we know definitely the quality of surface desired, we might develop new and more economical methods of producing them. The ingenuity of man has never failed to solve a problem, once the problem is stated definitely. It is the duty of this group to state that problem by:

1. Defining surface quality in universally understood terms.
2. Devising a definite and absolute scale for measuring surface quality independent of the appearance of the surface to the eye.

Consumer Must Be Educated

After deciding on a definition of surface quality, the next need is to educate the consumer to specify the correct surface quality for his particular application. Obviously, it is an economic waste to finish a surface smoother than necessary to do the job. Therefore, after the consumer, the engineer should be educated to adopt a standard and universally applicable set of symbols to designate surface quality on the drawings. Such terms as "finish smooth," "grind," and "hone" are not sufficiently definite. They fail to supply an exact measurement of the surface in the same manner that we measure the linear dimensions. How shall we attack this part of our problem?

Any symbols adopted must be easily understood. They must be such shaped symbols as the ordinary draftsman can make free-hand and in the shortest possible time. They must be small so that they will not clutter up the drawing, causing confusion in reading a print. They must be such symbols as might be identified by English names. Such devices as the Greek alphabet must be avoided. A numerical system would be desirable.

If design engineers and draftsmen are to adopt standard symbols for designating surface quality on drawings, they should be furnished with some guide for determining what surfaces are required for specific applications. Disregarding costs for the moment, is it possible for a surface to be too smooth for a particular use? There is a school of thought which says "yes." Some lubricating engineers say "no."

And how about surfaces which are to be covered with plating, painting and enameling? Does it lower the efficiency of a surface to be too smooth? If so, how are we to control the limits of smoothness? This is important, for at present it seems generally accepted that it is only necessary to put limits on the roughness of a surface. Anything smoother than the quality specified seems to be acceptable. This stand is open to serious question. There is enough evidence to show that a surface can be too smooth for satisfactory performance in a particular application. Hence the necessity of indicating the maximum smoothness as well as minimum roughness desired.

Proposed Standard for Surface Roughness

A start in this direction has been made by the A.S.A. in its "Proposed Standard for Surface Roughness." This proposed standard represents a tremendous amount of work by a large num-

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CHOOSING ASSUMPTIONS

(Continued from page 23)

of a speed range of 2:1; (that is if you have a 100 mile top speed you can land at 50) we can now have a top speed of 250 and still land at 60 or 65 which is a low landing speed. Our flying boats have jumped up from four passengers 10 years ago up to seventy-two passengers and the next step will be more than double the size of the latest big Boeing that just flew across the Pacific. The DC-4, weighs about 81,000 lbs., one of the largest land planes for passengers that has been built. The Boeing boat weighs about 110,000 lbs. Think of shoving that through the air and lifting itself. The new flying boats now laid out and being built for trans-Atlantic and South American service will weigh 225,000 lbs. with a cruising speed of 200 m.p.h. and with a range of 5,000 miles, 100 passengers and a crew of 16.

As we get to those sizes we begin to get airplanes that are more efficient in passenger carrying than any type of boat and we get into a tremendous field of transportation back and forth.

And so as research comes along our world is changing and as we change there is one thought I would like to leave with you Tool Engineers. Very often we have gone to the extent of tooling up on a job where, after we get it done or by the time we get the tooling done, that particular thing we are making has become obsolete and they are then loathe to throw away all those tools and start something new and hang on until the other fellow has our market. So in your production end, as well as in engineering, research for more flexible tooling, research for things that will enable us to change our product with the growth of progress is necessary. That is one step which should be more and more watched in all production less we get too much tools and too much investment and then can't change our ideas.

ber of individuals. Information has been collected and opinions solicited from all branches of industry. This proposed standard may or may not be in final form. It will probably have many shortcomings, but it can be changed, revised, and amended after we have acquired some experience with it. The thing for industry to do now is to get back of it and try to use it.

The criticisms we have had so far from people who have examined this proposed standard have had to do with means of measuring surface quality; what instruments are now available on the market and are these instruments sufficiently rugged in construction and simple in operation to be used in the shop.

Research workers have been busy in trying to develop an instrument for measuring surface quality. Most of them have attacked the problem by trying to measure the depth of serrations. I am not going to describe the various methods, but I will list them merely for purposes of discussion.

1. The microscope is the most widely used tool for examining surface. It can compare two or more surfaces, but cannot give a definite measure.
2. A phonograph pick-up has been used for measuring surface quality. The quality of a surface affects the pitch and volume of the sound.
3. Plastic casts are slow. They are subject to error in making the casts.
4. A beam of light impinging on a surface at an angle may be used as a measure of its quality. Ordinarily, the rougher the surface the greater the diffusion of the reflected beam, but oil and colloidal matter on the surface falsify results.
5. Professor Schmaltz uses a sheet of light projected onto a surface at an angle so that, looking through a microscope inclined to the surface, the observer sees a bright line following the contour of the surface. This seems to be the most practical microscopic method yet devised.
6. The Profilometer has found practical application in several plants. It employs a fine needle and an indicating meter which reads millionths of an inch directly. Any instrument for measuring surface quality must give a greater magnification to the vertical roughness than to the length. The Profilometer does this.

I have said that methods of producing a surface must be only a means to an end. However, if we know the available methods for producing fine finishes, we can use better judgment in designating limits on the quality of surfaces. Also, and which is more important, we get some idea of the relative costs of producing fine finishes. Therefore, we have with us this evening a number of men who will describe different methods of producing fine finishes.

Mr. Weaver (continuing): "As I have said previously, we are going to limit these men to a certain definite time of 15 minutes. We have here representatives of the different companies who produce equipment that produce surfaces by different methods. I would like at this time to present Mr. F. T. Ellis, Representative, Heald Machine Company, who will speak on 'Diamond Boring and Turning.' "

DIAMOND BORING AND TURNING

By F. T. ELLIS, Heald Machine Company

Just recently there has been an awakened interest in the precision finishing of metal surfaces characterized as "super finish," and "mirror finish." Several new processes in the art of metal smoothing have been, and are now being developed. You are all probably familiar with the work done at the Chrysler Plant, possibly have heard Mr. Wallace's explanation of some of the things he has learned in his struggle to improve the accuracy and smoothness of various sorts of surfaces. He has certainly stimulated a lot of interest in this idea.

It probably is no longer a matter of opinion, but a proven fact, that smooth, accurate surfaces contribute a lot to the long life, reduced friction and generally satisfactory performance of any mechanism.

The problem right now is how best to obtain them; first, of satisfactory quality; and next, as inexpensively as possible. Obviously, there are many possible methods. Some are now in use—and several more very ingenious ideas are in the experimental stage.

In this connection, there are two phases upon which I believe we will all agree. In order to secure a satisfactory surface, either round or flat, it must be accurate. It must be accurate before the polishing operation, of whatever nature it may be, is started. This surface also needs to be reasonably smooth; that is, free from deep cuts and tears, or the subsequent smoothing operations will be incapable of reducing the surface to a satisfactory finish. And, furthermore, that no matter what sort of polishing operation is used, honing, lapping, or similar processes, they are by their very nature unsuited to the removal of very much material and are, therefore, unable to do much corrective work.

Imagine what a rough ground finish looks like under the microscope. Then imagine the sort of surface that I might get on a precision turning and boring machine and you can readily understand that it is easy to turn that surface into a very smooth surface by a small amount of lapping and still not injure the accuracy of it. Therefore, it is quite necessary in finishing a hole or a shaft, that it be of proper size, round, straight, parallel, etc., and if the piece is flat, that surface must be accurate and true before you start the final finishing process.

Preliminary Finishing Processes

It is this preliminary finishing process that I would like to describe to you as performed on precision boring and turning machines.

In speaking of these processes, as performed on these machines, as "preliminary" operations, I refer to such parts as require the ultimate in a smooth glass-like finish and which, today, are considered much finer than what we commonly speak of as "commercial" finishes. So much work is being done right now in developing new methods of finishing materials, that it is very possible the near future will see surfaces produced by grinding or boring and turning, that will be satisfactorily smooth. Connecting rod bearings are even now being bored on precision machines to an almost perfect finish and, of course, to extreme accuracy. Also, pistons of aluminum alloy have been turned to a surface finish of 5 or 6 micro inches.

Smooth, accurate finish, aside from the question of tools, means freedom from vibration in spindles and other parts, absolute accuracy of alignment and absence of seasoning strains in castings.

Surprising Discoveries in Metal Behavior

As the art of metal finishing has developed, some surprising discoveries have been made. Some years ago, it was the opinion that cast iron was a rather rigid material. They realized that it seasoned and changed its shape as strains were released, even though they didn't know of any very good way of controlling these changes, but they apparently did not realize how very spongy it was and how it would elongate and compress under strains.

Also, until quite recently, there was not much scientific study of how to control distortion through proper ribbing and mass distribution in the main castings of a precision machine. New cast metals, such as Invar metal, an alloy but little affected by heat and not subject to internal strains, has made it possible to produce multiple-spindle boring heads, index fixtures and similar mechanisms which will remain accurate during the heat and strain of production.

New rubber compounds are now used for cushioning motors, pumps, and other units, which formerly contributed to vibration. Research into the design of tool supports and slides, has made it possible to increase tool life and at the same time take cuts which formerly were thought to be impossible.

In precision machines probably the most vital unit is the spindle. Volumes could be written on the developments and research that have taken place in the last few years. This is largely a problem of getting smooth, tight fitting ball bearings and obtaining proper balance. To the problem of drive, rubber belts have contributed a great deal.

When desired, these can be furnished with an automatic retracting device to prevent the tool dragging back across the work, thus increasing tool life and preventing a mark across the finished surface.

Cemented Carbides

When the first diamonds and cemented carbides, Tungsten, Tantalum, etc. came into use, they, like all new ideas, were quite limited in their application and very imperfect. However, great strides have been taken, even during the past year, until now quite wonderful results in turning and boring have been achieved. The problem seems to be to find a cemented tool which will retain its keen edge and still be tough enough to resist the shocks of cutting across holes or edges.

This has been particularly difficult in steel in the past, but by taking advantage of the best characteristics of the cemented carbide, its resistance to heat and abrasion, we now use a tool with very little top rake and a negative shear to throw the chip out of the way. We are successfully turning and boring tough, hard steels at speeds approximating 500 ft. per minute, and are getting a very smooth finish and satisfactory tool life.

The tool should have a negative shear to throw the chip out of the way. It is quite important to do this because cemented carbide is very brittle and breaks down and crumbles on the edge. A lot has been accomplished by the Carboloy people and other makers of cemented carbides in that respect and we have very successfully handled tough stock.

Gas-tight Joints Demand Precision Finish

In refrigerator manufacture where the joints must be gas-tight, precision finishing of the metal surfaces is imperative. Most of the progressive manufacturers are now using precision machines for turning, facing and boring on several of their units. In most instances these parts require no further finishing, although many of them are of steel. Their cylinder is a good example of accurate production, as it must be gas-tight without the use of special gaskets. The total limit on the thickness of such a cylinder is .0001.

As manufacturers become more conscious of fine finishing and as the equipment for producing it and the apparatus for measuring develops, some interesting problems come up. For example, one manufacturer complained (after he had secured a very accurate electro-limit gauge) that his bored holes were not the same size all the way through. It later developed that the error was due to heat expansion of the tool. It just goes to show how conscious some of the manufacturers are now of small amounts. The difference in diameter, in this case, amounted to only .000030 inch. We can all remember, some of us, when no manufacturer worried about such a small amount as that on a production job. They are beginning to take notice of those things today.

Special Boring Heads for New Tools

Tapered holes in large castings, such as heads for large machinery, and which are too large to swing readily, are now bored very accurately with special boring heads. This doesn't seem like a very practical proposition but actually it works out very satisfactorily. The first attempt to check it was made with a "blued" plug. It showed a surprisingly good finish and very accurate taper. It is a convenience to handle large castings by this method. It eliminates the necessity of making bushings. You get better alignment than by any other method. In the application of such methods both the plug and body ascend simultaneously with the tools on opposite sides. This is done so that when the cut is finished the tool can be retracted slightly and backed off without scratching the work which, of course, might cause an air leak.

Carburetor needles, valve bushings, tappet bodies and similar small parts can be handled most advantageously in magazines on the new machines at a greatly reduced labor cost over old methods. There is also a saving of expense for grinding wheels, diamonds, etc. These machines, being exceedingly simple in design and hydraulically operated, usually require very little in the way of maintenance and a very small amount of floor space.

While they were first introduced to replace work done by reaming or internal grinding, they have gradually crept into other fields of turning, recessing, facing, etc., and many precision jobs are now performed on precision machines which probably cannot be done as well on any other equipment.

For example, the rotor of a certain new pump had to be an exceedingly accurate job. The spacing on one piece was .0002. There was a little projection that had to be machined to a curve holding to a very close limit. You people who are familiar with manufacturing realize that such a job might be rather tricky work to be performed on any other kind of equipment. This job has worked out very satisfactorily.

Efficient Also for Rough Cuts

Instead of being used only for light finishing cuts at high speeds, it has been found that the very rigid and accurate spindle construction, the sturdy mechanism of these new heads has made them desirable for machining parts from the rough. Many times it is found that a single cut from a casting leaves a satisfactorily smooth and accurate finish.

There is now a fairly complete line of similar precision machines adapted to a great variety of operations. Their development has been so recent and their application so scattered among the various industries that the trade is not familiar with them all. As they become better known, the field for their use is bound to widen.

Those who are interested in economically producing their units with: a) accurate, smooth surfaces which will assemble square and true; b) with such fits as mean fine running conditions and long life; will do well to investigate the possibilities of precision boring and turning factory machines.

GRINDING

By IRA SNADER, Research Engineer, Ex-Cell-O Corporation

We are today "finish conscious" to a degree that has not heretofore been known. This interest in better finishing on metals has grown out of the requirements of our highly developed industries, to make better finishes available for accurate interchangeable parts manufactured in large quantities at a reasonable cost. I shall attempt to relate grinding as a method of removing stock and obtaining a surface finish compared to other available methods of accomplishing that objective.

Ex-Cell-O has been called upon to discuss this subject because of our wide experience in the many methods of grinding and types of grinding equipment. Our problems, like yours, are those of the users of grinding methods. The grinding machine in its several forms has been recognized for many years as the only acceptable standard machine tool suitable for removing an appreciable amount of stock from a piece of work and at the same time producing the required accuracy and acceptable surface finish.

Grinding maintained this enviable position until the development of the precision boring machine. In 1930 we introduced the first diamond boring machine, a machine which was especially built for finish machining by diamonds. It was also furnished with carbide tipped tools or non-ferrous tools of greater hardness and since that time the machines are known as precision boring and facing machines.

These two metal working methods, grinding and precision machining, are used today almost entirely for correcting previous inaccurate machining operations and heat treat distortions and for establishing accurate size dimensions and form on the work.

Grinding Will Stay in Picture

The other methods of finishing to be discussed are not so well adapted for removing a substantial amount of stock.

To a great degree these methods must depend upon the ground or precision finished surface to obtain the required size and form such as roundness, flatness, and straightness. Therefore it is definitely established that grinding will not pass out of the picture as an obsolete operation. On the contrary the further development of supplemental operations such as honing, lapping and the latest metal working developments, "super-finishing," etc., will tend to develop a more comprehensive appreciation of a good ground surface as a basic requirement. The use of grinding machines will become more and more extensive with the development of the supplemental finishing methods.

The choice as to the method, or methods, to be used in finishing any particular part must depend upon the requirements of the finished surface and the accuracy of the dimensions desired to provide for interchangeability of mating parts. Especially to be considered is how high a degree of finish, consisting of smoothness as well as flatness of surface, is required on the part.

In recent years devices have been placed on the market for supplementing the microscope and the measuring micrometer for checking or measuring the surface finish. It is to be noted that parts produced by the different methods of finishing may have identical measurements in some of these devices but they may appear different in appearance. That is especially true if observed under a microscope. The bright surface finishes regardless of the manner in which they are produced are not necessarily in all instances the most accurate with respect to surface flatness or dimension.

Grinding is a method of removing material from a piece of work by means of an abrasive wheel. The wheel in most instances revolves at a relatively high rate of surface speed with respect to the speed of the work which traverses past the wheel. The grinding wheel has a rather small area of contact with the work and in this respect grinding differs from other abrasive finishing operations.

Honing, Lapping Has Greater Area Contact

For example, in honing or lapping the abrasive element has in comparison a much greater area of contact. The scratches produced are of much greater length than those produced in grinding and they usually cross each other in many places.

In grinding the abrasive element, or wheel, makes only a line contact in engaging the work. The rapidly revolving wheel causes small grain particles of the wheel to remove minute chips from the work. This results in producing a finish with the characteristic appearance of microscopic parallel scratches adjoining each other throughout the ground surface. These scratches are rather short. Their length is variable by altering the relationship of the work speed with the wheel speed. The size and depth of these scratches and consequently the appearance of the finished ground surface can be varied considerably by selection of grinding wheels having different grain size or bonding materials. During the grinding operation it is inherently necessary to remove enough stock from the work to be sure the finished part will be cleaned up all over or ground on all the surface that was intended to be ground.

A coarse grained grinding wheel will remove this grinding stock from the work very much faster than a finer wheel but the finer wheel when kept properly dressed will produce the best finished surface on the work. The fine grained wheel will, however, under normal conditions not cut as fact as the coarser wheel. That will be elaborated on just a little later in this paper.

We are thus confronted with the problem of whether we shall grind the parts with a coarse wheel at a high rate of production and have a finish that is not so good, or whether we shall grind them with a finer wheel at a lower rate of production, but having a much better surface finish. Usually a compromise between the two is made. Quite often the grinding wheel manufacturer can help the job considerably by suggesting a wheel that is particularly adapted to that job. In other words, the grinding wheel manufacturer can suggest a wheel that will give you a good finish and still remove the material from the work rapidly.

If the parts under consideration require an exceptionally smooth finish we may then consider the advisability of rough and then finish grinding. First using the coarser wheel for rapidly removing the stock to a size close to finish size, and following this with a much finer wheel with light cuts to obtain the desired size and smoothness of surface finish. With proper selection of wheels, wheel speed, surface speed of the work, and traverse or feed, an exceptionally good surface finish can be obtained. Production and cost of work so produced compares very favorably with other methods.

Simple Methods Frequently Overlooked

The method in fact is so simple I fear it is often overlooked, or not considered seriously enough, along with other methods that are supplemental to grinding. When Ex-Cell-O in 1935 introduced this method on the American market the first thread grinder as a standard machine tool with oil recommended as coolant for the wheel and work.

This was done because it was found that in grinding threads with oil as a coolant harder and finer wheels could be used and thus maintain a sharp corner on the wheel. The hard wheels permitted much greater wheel speeds than are commonly used on ordinary grinding. Speeds approximately twice as fast as the conventional grinding speed made it possible to use the finer wheel with a resulting good finish.

Production was not sacrificed because a finer wheel at the higher speed will remove stock as fast as the coarse wheel at the conventional slower speed. Thus no time is lost in using the finer wheel and at the same time a better finish is obtained by the finer wheel.

Please do not get the impression, however, that I suggest that you fill the coolant tanks of your grinders with oil. If you do you may get into plenty of trouble unless your machines are adapted for it, and the necessary precautions for handling the oil are observed, as is done in the design of a modern thread grinding machine. The oil was mentioned merely as one of the elements used in this particular instance to secure an unusual good finish ground surface.

Wheel and Work Spindles Important

Other but equally important elements are the wheel and work spindles which are equipped with closely fitted precision ball bearings, thus permitting higher speeds and smoother operation.

With conditions as they should be on any of the present modern grinding machines equipped with proper abrasive wheels it is truly remarkable what may be accomplished in the way of accuracy as well as finish. However, just as the selection of an automobile today is quite difficult because they are all good cars, likewise the selection of the proper method of securing a suitable surface finish is also difficult.

In the final analysis, it depends to a great extent upon what you want to do with it after it is acquired. It has been difficult in the time allotted to this subject to do any more than state fundamental surface finishing premises. The range and variety of grinding equipment in our plant, as well as the large volume and variety of work being done will, I am sure, be of further interest to you. You are invited to visit our shops to see the operations performed and discuss grinding developments with us.

HONING

By KIRKE CONNOR, President, Micromatic Hone Corporation

The increasing interest in improved surface finish is most encouraging to all who have taken time and effort toward developing the art. The "Profilometer" has been a tremendous benefit in this development by providing a dependable measurement of relative smoothness.

Honing is more than a mere "beauty treatment." It is a combination of four results in one process which generates "surface character"—size and bore ac-

curacy—and desired degree of surface smoothness, and efficiently removes stock. We shall try in the time allotted to show how this is accomplished.

Surface Character

Surface character comprises the physical qualifications, not only of a boundary surface, but also of the adjacent material which supports that surface. It is the aggregate ability of a finished surface to support load bearing operation with minimum frictional and fretting wear—to provide maximum strength in resisting percussion, fatigue failure and corrosion—to support unbroken film lubrication—to promote rapid heat transference—and, to permit the most favorable precision fitting of assembled parts.

Surface character is determined by the manner in which stock is removed by shearing action. Shear is defined as an action or stress resulting from applied forces which cause or tend to cause two contiguous parts of a body to slide relatively to each other in a direction parallel to their plane of contact. It is produced fundamentally by stressing material beyond its rupture, or fractual point. In doing this work, some adjoining material is usually stressed beyond its yield point, forming a region of structural deformation which impairs the efficiency of the boundary surface. Successive machining operations, while removing all, or part, of this deformed material, generate more regions of similar, new deformations. This overstressing below the plane of fracture was particularly noticeable in some moving pictures recently shown before the Detroit Section of this Society by Dr. Hans Ernst, Director of Research of the Cincinnati Milling Machine Company.

Surface Character Depends on Manner of Stock-Removal

To a very large extent, surface character and finish is dependent upon the manner in which stock is removed by any machining process. It is most successfully accomplished by methods and equipment which provide the maximum, mechanical balance of design, construction and operating factors in machines and tools. From an abstract point of view, most conventional machining operations obtain a remarkable degree of accomplishment under favorable operating conditions. Such critical factors as the relative unit weight of assembled machine parts, the machine foundation, inertia, vibration, and centrifugal forces, are minimized, if not wholly eliminated. The accomplishment obtained by precision boring and grinding equipment, as related to improved spindle bearings alone, is a wonderful mechanical achievement.

The hone abrading method of bore processing is singularly fortunate in its relative freedom from these critical factors of machine balance. The magnitude of the result obtained by honing is relatively independent of the operation of the machine for the following reasons:

The entire control of pressure application is designed into the tool adjustment mechanism. Universal joints in the tool provide compensation for minor misalignment of the spindle and work, and eliminate high spindle bearing maintenance costs. All abrading cutting elements are solidly supported by the tool construction, and the tool is supported concentrically by the work itself. This assures balance shearing force application and eliminates the possibility of structural deformations due to quill or spindle bearing limitations. No other abrading process provides these features.

Honing Uses Multitudinous "Cutting" Tips

The honing process uses a multitudinous number of "cutting" tips in a large total area contact of bonded abrasive grains. In fact, it uses more simultaneous shearing contacts than are used in any other abrading method. These abrasive grains are crystalline. They are bonded together, with vitreous bond posts. Both are abrasive grits, and the bond posts are fracturable under pressure application.

For example, in a bore 3" in diameter by 8" long, it is estimated that six 150-grit stones would have over 140 times the abrasive area, and some 98,000 odd shearing contacts, as compared with 46 contacting grits in a "line" contact using a 46-grit internal grinding wheel. In other words, honing would have over 2100 times as many simultaneous shearing contacts.

In a corresponding finish honing operation, using 500-grit stones, honing would have over 350 times the abrasive area and over one million, or 36,000 times as many simultaneous shearing contacts as compared with 112 contacts using a 60-grit finish grinding wheel.

This multiplicity of contacts permits low unit stress application over a large area contact with the work. It assures uniform depth of shearing action and influence. It eliminates overstressing of adjoining material in shear because of the fracturable, crystalline character of the abrasive, and of its vitreous bonding material. If total horsepower input can be considered to represent the total heat generated, this means that the maximum amount of heat generated per individual grit would be .002 of one B.T.U. in rough honing, and only .0002 of one B.T.U. in finish honing. Grinding, comparatively, would generate respectively 2300 times and 9500 times as much heat per individual grit.

Pressure

To accomplish any amount at all of shearing action, pressure, combined with motion, is required. The amount of pressure required in honing depends upon the relation of shear resistance of the abrasive bond to the shear resistance of the material. For this reason, stock can be removed in hard steel bores much more rapidly with lighter, rather than heavier pressures.

The amount of pressure per unit area, or per individual grit, in honing is minutely smaller than in grinding. In the above mentioned 3" diameter bore, rough honing would have over 2,000 times less pressure, or about 1/7 of an ounce, and finish honing would have more than 36,000 times less pressure, or about 1/100 of an ounce per individual grit, as compared with a corresponding grinding application.

Control of pressure application in honing tools is provided either by mechanical, or hydraulic, actuation. With the hand-brake type of mechanical adjustment, it is possible to maintain a correct pressure cycle; that is, starting with low pressure, increasing to higher pressure, and ending with diminishing or run-out pressure. This accomplishment, however, is almost entirely dependent upon the skill of the operator.

Mechanically actuated automatic type tools, in which pressure application is obtained by means of a caged spring, provide more consistent control of pressure application and consequently, more uniform production and results as related to accuracy and finish. Spring pressure inherently loses its force as the spring elongates, thereby decreasing unit pressure during the work cycle. This serves to limit economical stock removal, but is entirely satisfactory for finish honing, where diminishing pressure is advantageous.

Hydraulic Control

Hydraulically controlled actuation of pressure application, permits unlimited combinations of pressure adjustment during the operating cycle. By this means, pressure can be increased or decreased in proportion to the amount of work to be done, and according to the degree of control desired in creating final surface smoothness. It comprises the greatest advancement in the honing process since the perfection of the automatic type tooling.

Let facts speak for themselves. Automatic, mechanically actuated tools, used on a hardened cast-iron replaceable sleeve, removed .005" stock at the rate of .001" per minute, at a stone cost of 3½ cents per sleeve for maximum, economical productivity. Using hydraulic pressure control on the same job, an average of .022" stock is now removed, at the rate of .010" per minute, at a stone cost of only 3.7 cents per sleeve. In other words, over 4½ times as much stock is removed, ten times faster, at approximately one-fourth the cost per cubic inch of metal removed.

In a 6" diameter forged steel gun bore, this type of pressure control recently accomplished the removal of .100" stock, at the rate of 012" per hour, at a stone cost of ½ cent per cubic inch for a total of 486 inches of metal removed. This bore, by the way, was 21½ ft. long.

Speeds

Honing speeds are established according to the time required for penetration of the abrasive girts, and the amount of pressure application. Conventional operating speeds are selectively arranged in combinations of

rotations and reciprocations which will produce a surface travel varying from one, or two, to 250 ft. per minute. Higher speeds tend to retard penetration and, therefore, reduce operating efficiency. In this respect, there is no comparison between the use of a large area contact and a line contact of abrasive, as in grinding, where shearing fracture is more dependent on speed.

Coolant

Honing is fundamentally a wet cutting process. The cutting fluid, commonly called "coolant," performs four important functions in producing favorable surface character, and finish, as follows:

1. To assist rapid shearing action of the abrasive by producing a favorable type of chip formation, which will not cause structural deformation in the resulting surface, and thus avoid "loading" into the stone.
2. To support the abrasive in control of cutting action and smoothness of surface finish by serving as a lubricant between the stones and the work surface, and retard penetration under low pressure application.
3. To remove chips and abrasive residue by acting as a flushing agent.
4. To carry off frictional heat of any degree by acting as a coolant.

Size and Bore Accuracy

Bore accuracy is dimensional accuracy of diametric size, and roundness, diametric straightness, and axial straightness.

Dimensional accuracy in honing is accomplished by actuating the abrasive in a varying direction of travel, or motion. This travel path, combined with equalized pressure through the abrasive area, produces a continuous self-dressing action which assures uniform abrading effort at all times during operation. It comprises various combinations of rotations and one or more longitudinal reverse traversing motions, called reciprocations, all operating simultaneously. Where desirable, the work may also be rotated, or reciprocated, or both.

These combined motions generate either a simple, or a compound, harmonic abrasive travel path of varying direction and rate of surface travel. The simplest form of harmonic motion is shown on the left-hand side of Figure 1. For purposes of simplicity, the ratio of individual motions as here shown is slightly more than two revolutions to one cycle of reciprocation. The area of work abraded, if conceived as a metal shaving, would be as shown in bottom-right, Figure 1.

The paths of a number of stones, positioned at spaced intervals in the hone body, will cross each other many times during continued operation, as shown in Figure 2. With a wide range of selection in establishing the pitch angle of travel, and with a uniform rate of abrasive fracture, it is not even remotely possible for a grit to cut a continuous spiral or to follow in any of its former paths. Uniform abrading effort is further assisted by selecting a ratio of motions which is not evenly divisible, such as 3. to 1. This produces the overlap of stone position shown in Figure 2.

Uniform abrading effort is, in part, the amount of coverage of work surface by each abrasive grain under uneven ratio actuation. This is exemplified in Figure 3. The top graph is typical of the coverage of work surface area by a single grit in honing actuation. It is the equivalent in mechanical actuation of one rotational motion and two reciprocational motions, all working simultaneously.

These combinations of odd ratio motions are practically unlimited, and can be selectively arranged for any degree or type of finish desired. This type of actuation is of greater importance in more rapid stock removal, stone life, and production of plano-concave surface smoothness that it is in production of bore accuracy.

The bottom graph, Figure 3, shows the coverage of a single grit under an even ratio of mechanical motions. This grit path will repeat itself indefinitely.

Accuracy for Size and Roundness

Accuracy for final dimensional size is produced by controlled limitation of abrasive expansion provided in the tool.

Accuracy for diametric roundness is accomplished by the rotary motion of the hone, and the freedom of the tool to center itself with the neutral axis of the bore.

Accuracy for diametric straightness is produced by the reciprocation, or longitudinal traverse of the tools, combined with positive expansion and equalized pressure application throughout the length of the stones and the working stroke. This readily permits the correction of error for taper.

Accuracy for axial straightness is accomplished by the use of sufficiently long stones to overcome any axial deformity in the bore. Stone length is established in relation to bore length, to assure uniform abrading effort or coverage of the work surface. This requires that the longitudinal travel path generated by opposite ends of the stones at the ends of the stroke shall not overlap.

Surface Smoothness

Mechanical surface smoothness serves only to supplement surface character and accuracy. It shares in contributing quality improvement. It requires the support of favorable surface character and accuracy to accomplish maximum efficiency in load bearing operation.

The generation of plano-concave, surface smoothness on crystalline material by mechanical means, requires exceptional control of positive stock removal. This must be accomplished by a combination of sufficiently diminishing pressure or stress application and speed adjustment to cause only superficial shearing action, and the elimination of injurious frictional heat. In industrial use it must be economically productive.

The balanced shearing action provided in the hone abrading method accomplishes any degree of surface smoothness desired in production.

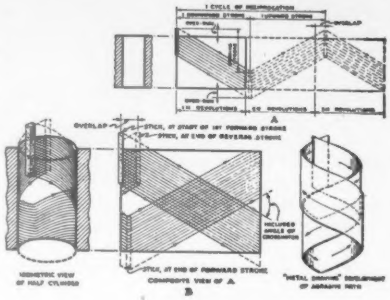


Figure 1.

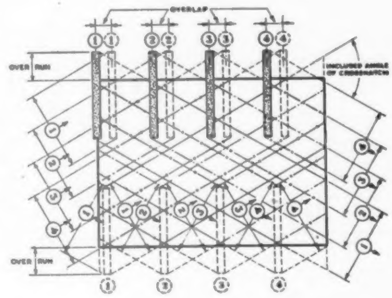


Figure 2.

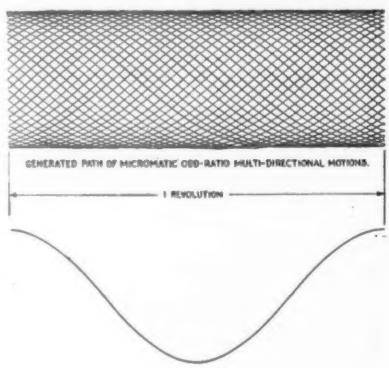


Figure 3

Facts Speak for Themselves

Automobile cylinder bores and replaceable sleeves are being regularly finished within 2.8 to 5 micro-inches of planar smoothness in the majority of manufacturing plants.

One of the larger plants has been finishing the crank shaft bore in connecting rods for the past seven years with 1.5 to 2 micro-inches, at the rate of 350 rods per hour, per machines.

Roller bearing sleeves in production are finished within 1.8 micro-inches.

Refrigerator rollators in production have surface finish of .8 to 1.6 micro-inches.

Radial aircraft engine barrels have regular production finish of 1.6 micro-inches.

Master connecting rod crank pin and knuckle pin bores have production finish of 1.6 to 1.8 micro-inches.

Miscellaneous cast-iron and steel parts used in various industries are being regularly micro-finished within .8 to 1.6 micro-inches of plane surface smoothness.

Conclusion

The honing process provides production adaptability to a greater extent than does any abrading finishing process:

It provides high productivity with very low capital investment.

It accomplishes a substantial amount of stock removal economically in balance with the combined result desired.

It does not over-burden previous operations by requiring maximum precision accomplishment.

It removes structural deformations produced in previous operations, without generating similar, new deformations.

It corrects error produced in previous operations.

It eliminates injurious frictional heat generations in the finishing operations.

It generates any desired degree of surface plano-concave smoothness on crystalline material by positive, controlled shearing action.

"SUPERFINISH"

By D. A. WALLACE, President, Chrysler Division, Chrysler Corporation

"Superfinish" is the name given to the new type of finish developed by the Chrysler Corporation. It is obtained by passing a coarse bonded abrasive stone, properly lubricated under low pressure, slow multi-motion, over and round a flat convex or other type of surface that has been dimensionally finished by turning, grinding, honing or lapping.

"Superfinish" removes the layer of "fuzz" or free molecular amorphous metal developed on the surface by the above four methods of finishing, and the removal of this layer of "fuzz" or amorphous metal exposes the hard crystalline structure of the metal to a smooth finish, free of sharp metallic projections left by grinding methods that rupture oil films under pressure.

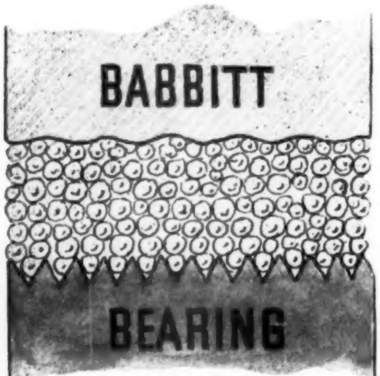


Figure 1.

Uneven surfaces, with projecting points require excessive lubrication to minimize wear.

Figure 2.

When oil film is too thin, projections rupture oil film, cause excessive wear.

Wear is practically eliminated upon "Superfinished" surfaces and this of course permits doubling of bearing load capacities and allows the engineer to design bearings of smaller size and lighter weights with equal load carrying capacities.

Why do tool engineers have to give serious consideration to finishes? The answer is that the physical properties that exist in lubricating oil are such that when oil is heated, the globules of oil continually break up into smaller globules. If the oil is permitted to heat to too great a temperature, it will entirely disappear and permit metal to metal contact.

Oil Molecules Act as Ball Bearings

Molecules of oil are being described by a great many scientists as ball bearings and if you will refer to a recently published booklet by the Shell Oil Company entitled "The Fundamentals of Lubrication" you will find that the oil physicists agree with this theory.

It would appear that even though oil is in a bearing in the form of a globule, these globules of oil are of a certain definite molecular thickness.

Lubrication is possible with three molecular thicknesses of oil, but in order to lubricate with three molecular thicknesses of oil, the two bearings must have perfect surfaces. Therefore, if a surface is not perfect, it is necessary to use more oil in order to eliminate metal to metal contact. (See Fig. 1 and 2.) These charts clearly demonstrate that with "Superfinish," all sharp projections are removed and a flat surface substituted for a jagged surface, and they also indicate that a jagged point on a ground surface, even though only one-millionth of an inch high requires three times as much oil as is necessary for lubrication. Therefore, the problem of increased load carrying capacities or the reduction of bearing area sizes is not a problem for the lubricating physicist and engineer, but rather a problem for the factory and the shop. It is necessary for the factory and shop to be supplied with equipment that will produce a surface not only free of jagged, sharp projections, but also a surface on which any defects are below the surface that is being lubricated.

Three Types of Bearing Surfaces

There are three types of surfaces to be finished on which wear can be eliminated. These types of bearings are as follows: A lubricated bearing such as crankshaft or main bearing; a non-lubricated bearing such as contact between brake lining and brake drum; and the third is a surface that affords sufficient contact on the back side of a bearing, such as a main bearing, to easily support the load and give greater heat absorption capacity due to increased area contact.

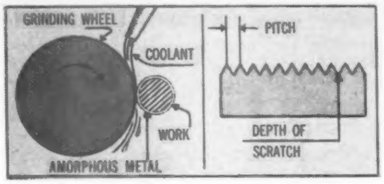
In finishing surfaces the first method used was by turning. The first finish was made on the geometric principle that a line is a point moving forward and a surface is a line moving forward.

Industry wanted something better so grinders with large grinding wheels were introduced. A grinding wheel has a surface, a line on this surface is in contact with the work and this line is moving forward. This line produces a surface. It is much truer, much smoother, if it is properly made. The heat produced at the point of contact is much greater than the heat generated in turning, because you are not only removing more metal, but removing it by pure force of friction. That is, the points on the wheel take hold and pull other parts out because there is no cutting action. The result of this is that the temperature is tremendously high.

Grinding Method

The grinding method of finishing metal surfaces is the method most universally used in industry at the present time. It is used to reduce the part being finished to size or dimension and to develop the surface finish simultaneously with the size. There has recently been developed, from data announced by us, a method of finishing surfaces on round parts such as bars, etc., to a very smooth appearing finish, which finish is being given such names as the following: Super-ground Finish, Polished Ground Finish, Mirror Finish, Micro Finish.

These types of finishes which apply to only one phase of surface finishing are usually produced by using a bonded abrasive wheel with fine abrasive grain. The grinding wheels are revolved at very slow speed, similar to our "Superfinish" methods, as compared to ordinary grinding. While this finish has a fine appearance to the uninitiated and inexperienced and often has very low micro-inch reading, it is a defective bearing surface for heavy load bearing capacity because it will show wear. This finish is what metallurgists have always called in the laboratory "smear finish" and this "smear metal finish" is the result of kneading action on the free molecular amorphous surface inducing a degree of heat that causes it to flow. It has been described



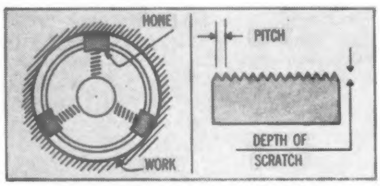
Grinding—The Process and Finish

by one great physicist as "vitreous amorphous" but the surfaces developed by this slow revolving wheel with bonded fine grade stone, when compared to the "Superfinishing" operation, clearly indicates, in my opinion, the fallacy of trying to make a load carrying finish that will stand up under industrial operation by this type of grinding method.

Honing

The next method of finishing surfaces is called honing, as it is known today. Honing first was used to put a good cutting edge on razor blades and because the razor manufacturer was able to obtain a smooth surface on a razor blade, they decided to give the process this name. This is the first method of finishing that began to depart from methods of refinement.

There is one other method of finishing—that is lapping. This finish was produced with a powder and lubricants and whether you rub two pieces together or whatever method you use it is possible to lap and leave a fine smooth surface. Every time a good finish was developed, there was a ten-



Honing—The Process and Finish

dency to try to call it a lapped finish. But if we had to finish a crankshaft or similar part by this method, we could not produce them economically. Therefore, it is necessary to eliminate lapping as a commercial method for finishing surfaces for mass production.

Grinding and abrasive cloth finishes (sometimes called sand paper finishes) have a common defect for load bearing surface finish in that they leave on the surface defects or scratches with sharp peaks which rupture oil films under pressure. In contrast to this, a ground or abrasive paper finish that has been "Superfinished" has a few remaining surface scratches or defects, which exist below the surface where they do no harm to bearing surfaces and do not cause oil film failure with as much as double the bearing pressure.

Superfinishing

During our first experiments with "Superfinishing," we used low pressures and relatively high speeds. We found that the work did not clean up, so we reduced our pressures and speeds still further and we discovered that the work did clean up quicker. Our present "Superfinishing" Machines have an oscillation of ⅛ of an inch, which is a rather long oscillation. The work rotates and the stones move back and forth. We will discuss these three motions. There will be two motions working simultaneously which does, geometrically, tend to make truer surfaces. With more than three motions in operation simultaneously, regardless of the tool, it will tend to correct it geometrically.

These stones are moving both ways, ⅛ inch over and ⅛ inch back. That is a quarter of an inch. This means the stones would have to move four times to travel one inch, and they will have to move 48 times to travel a foot. If we oscillate the stone at 1,000 oscillations per minute and for the sake of argument say it takes 50 oscillations to travel a foot, we would move the stone at the rate of 20 feet a minute. This is nothing like 5,000 or 6,000 or 2,000 feet, as we ordinarily do when grinding. A great deal of fine work can be done at one and two feet per minute. The reason for that is that this loose material on the surface is relatively easier to remove from the surface you are finishing than it is to rake fresh snow off the hard ice on a lake. Most surfaces can be "Superfinished" in from 20 to 40 seconds.

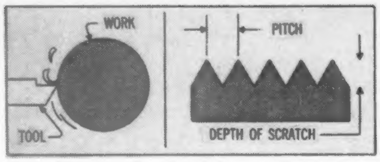
Camshaft "Superfinished" in 40 Seconds

A good example of how quickly you can "Superfinish" a surface is that in 40 seconds we have "Superfinished" camshaft bearings that were turned and had a profilometer reading of 50 micro-inches, which is a fairly good turning job, to a profilometer reading of 3 micro-inches. That is a very fine finish and better than you can obtain any other way because the scratches are below the surface where they cannot do any damage.

To do this we use low pressures and slow speeds which do not generate heat. Therefore, we are working upon a surface that is somewhere between 1,500 and 3,000 degrees cooler than it is when you are grinding. As a result, we do not form a decarbonized or a granular surface.

We discovered that when the "Superfinishing" stones reached base metal they stopped cutting. I used to wonder why a piece of abrasive could do this work so fast and then stop all of a sudden. Like all things with which we are not familiar, we usually call them phenomena and that is the way we cover up most of the scientific things we don't understand. We could not understand why the stones would clean off the surface so fast and then stop work, but the more we studied this condition, the more we were convinced that it was the lubricant.

We had multi-motion, we had slow abrasive speed, we had low abrasive



Cutting—The Process and Finish

pressure and with these three combinations there must be something that prevented the stones from cutting. We finished some bearings without using any lubricant and the stones did not stop cutting when they reached base metal. Further tests indicated that increasing the viscosity of the lubricant had a tendency to stop the stone from cutting. We are still studying this condition to learn more about it.

The amorphous metal on the surface of all work, after turning or grinding is similar to a thin coating of wax on a sheet of glass. You can draw a glass cutter across the surface of the wax and it would only cut into the wax the depth that its own weight would cause it to penetrate. By increasing the pressure on the cutter, the blade would penetrate deeper until it reached the glass. This same condition exists in "Superfinishing." You can balance your stone pressure with the viscosity of the oil used so the "Superfinish" stones will stop cutting when they reach the crystalline surface. The pressure required to remove the amorphous metal is a great deal less than the pressure necessary to cut into the crystalline metal.

Superfinishing Removes Only Amorphous Metal

All you do when you "Superfinish" a surface is to remove the amorphous metal—you do not make a dimension—you do not correct taper or out of round conditions—you simply produce a first class load-carrying surface—and that is what you seek.

"Superfinish," due to its universal application and unusual method of application can be used to produce flat surfaces of practically any size from two or three feet in diameter to optical flatness, or a flatness that will show the colors of the spectrum, and round bores to any degree of accuracy that may be desired both as to dimension and as to finish.

"Superfinish" is the only mechanical method yet devised that universally will finish either a turned, ground, honed or lapped finish of any roughness up to two micro-inches and on any type of surface—round, flat, parabolic, etc., and on any type of metal such as steel, iron, aluminum, brass, etc., which material may be either in a soft or a hard condition, to a fine smooth finish free of sharp projecting scratches and with a smoothness, measured by a profilometer, of from 0 to .0000005 of an inch and at speeds of from two to twenty times as fast as grinding, and leaves a crystalline surface exposed which, when properly lubricated, will totally eliminate wear.

LAPPING

By H. J. GRIFFING, Research Engineer, Norton Company

Due to the fact that mechanical lapping is a comparatively recent development, it is desirable we all understand what it is and its relation to other machining processes.

Hand lapping for many purposes, primarily the fashioning of jewels, has been in use for centuries.

Mechanical lapping first came into use about 40 years ago when C. E. Johansson of Sweden produced flat gauge blocks guaranteed within a few millionths of an inch for dimensional accuracy. Similar methods were developed and used for making gauge blocks in the United States during the war period of 1914 to 1918.

Lapping is an abrasive finishing process and is one of a group of abrasive processes including "super-finishing," micro-lapping, polishing, honing, and super-fine grinding. It is grinding performed with fine abrasive wheels similar to those used for lapping, and at relatively slow speeds. Results approach lapping, especially on large parts which are too large to be accomodated in present lapping machines.

Micro-lapping is a recently coined name. It means lapping for dimensional accuracy, together with the production of surfaces which are specified to micro-inch designations.

The primary object in mechanical lapping operations is to obtain dimensional accuracy at a lower cost than by any other commercial process. The secondary object is refined surfaces which are produced in securing the dimensional accuracy.

The nature of commercial lapping motions embodied in machines is to set up entirely different paths for abrasive mediums to travel than have been used in previous operations such as grinding, turning, etc.

There are three general types of lapping machines:

The first is the oldest and employs laps of cast iron, bronze, or other soft metals, and a loose abrasive usually mixed with oil.

The second is an outgrowth of the first and employs fine abrasive discs or wheels bonded with any of the several types of bonds.

Two Types Have Much in Common

These two types have much in common in that both flat and round work can be lapped by using suitable work holders. In general, the cast-iron lap machines are arranged to have one lap stationary and the other revolving, the work holder being revolved at approximately half the speed of the rotating lap.

In the bonded abrasive machines, or, as they are frequently called, wheel machines, both wheels revolve and in opposite directions, one slightly faster than the other. The work holder revolves at approximately one-half of the difference in the speed of the two wheels.

Work holders for flat work may be simple plates with holes for the work; or may be more complex arrangements with planetary adapters which carry the work in suitable holes, and of themselves revolve about a central oscillating and revolving disc, and are held in place by an outer compression ring which is free to float and follow the oscillations. In either case the resultant motions are such that the work is carried over an ever-changing break up path, the object being to distribute the wear evenly on the laps and produce work of a desired accuracy.

Precision gauge blocks are made to three degrees of accuracy for size, the first of which is plus or minus 8 millionths of an inch, or a total of 16 millionths.

Commercial Work to 25 Millionths Limits

Much commercially lapped work is produced in everyday production to limits within 25 millionths. This is close to gauge block accuracy. Furthermore the surfaces on commercial work, measured by profilometer readings, are between 1 and 2 micro-inches R.M.S.

Also the lapped surfaces so produced are flat within a few millionths, and the two opposite surfaces are parallel within a few millionths. Actually when using flat lapping machines it is difficult not to produce flat, parallel surfaces.

It must be realized, however, that the preparation of the parts and the type of machine and work holders used have some effect on the results. Round work is lapped in both the cast-iron lap and the wheel lap machines. The work holders are of types suitable for the varieties of work to be lapped.

The work holder is driven by the rolling action of the parts between the laps. The speed of revolution of the work holder or spider is half the difference in the speeds of the two laps. An eccentric motion is imparted to the work holders by a mechanism embodied in the machine. The resultant action is a reciprocating and a differential creeping action between the work and the lap surfaces, which produces the lapped finish on the work.

Representative flat parts which are finished to high degrees of accuracy on flat lapping machines are gears; gear cover plates and side plates for rayon pumps; oil burner pumps and gas compressor pumps used in electric refrigerators; gauge blocks; spacing washers; sides of ball bearing rings; airplane and automobile piston rings; revolving seal rings and many other similar parts.

Representative round parts are standard piston pins for automobile engines and larger pins for Diesel engines; rollers for roller bearings; valve stems, mostly for airplane engines; plug gauges; plungers for Diesel engines; fuel injector pumps and injection nozzles; and many other such parts.

Most of the parts which require mechanically lapped accuracy and finish are comparatively small. Consequently the present lapping machines are designed to accommodate small parts.

Maximum Sizes for Lapping

Maximum sizes of parts which can be handled in multiple groups in work holders range up to maximum dimensions of about 4" diameters by 7½" long for round work; and about 7-inch squares and 8-inch round discs up to 3 inches thick for flat work. (The average production on small parts is about 100 per hour.)

Until the past year or two, finer finishes and closer limits of dimensional accuracy could be obtained only by the use of cast-iron lapping machines. Recent developments in the manufacture of very fine grain lapping wheels of bonded abrasive have brought the use of machines employing such wheels up nearly to a par with the cast-iron lapping machines. This is a very important advance in the art of lapping for four reasons:

1. The use of cast-iron laps and loose abrasive necessitates a careful cleaning operation to remove all abrasive particles from the lapped parts.
2. Bonded abrasives are used with soap and water or some other lubricant and the work seldom requires any cleaning operation except drying, which takes place almost automatically and without any effort on the part of the operator.
3. Bonded abrasive laps may be used on all parts of cast iron, bronze, or any soft material with positively no bad effects from charging the surfaces with abrasives and turning the parts into future laps.
4. Bonded abrasive laps will produce results comparable to cast iron and loose abrasive laps in much less time.

We particularly call to your attention the important features of the results from both processes.

Flat parts have both surfaces finished to accurate flats and are parallel to each other. Round parts are round and are of the same diameter from one end to the other. All parts finished at one time, whether flat or round, are of the same dimension within extremely fine limits. This is an important advantage in production precision manufacturing and will save a great deal of time and cost in assembly, because it eliminates costly selective operations.

Third Type of Lapping Machine

The third general type of lapping machine is that which employs coated abrasives. Coated abrasives, whether of paper or cloth, and whether of ordinary sand or refined manufactured abrasive, are commonly known as sandpaper.

Few who have not had the privilege of a trip through a coated abrasive plant can realize the complexity of the intricate engineering and manufacturing controls that are required to produce uniform products. Consequently few appreciate the advantages of using coated abrasives for certain lapping operations that demand dimensional accuracy and fine surface finish under unusual conditions. The two outstanding uses for coated abrasives for lapping operations are for crankshafts and camshafts.

Lapping machines for crankshafts are designed to lap all crank main bearings and all crankpin bearings simultaneously. Due to the flexibility of the paper or cloth, all diameters, fillets, and thrust surfaces are finished in the same operation. Also the design of the holder is such that dimensional errors of out of round and taper are minimized.

Crankshafts are comparatively soft, which makes high finishes difficult to attain. But, if the grinding finishes are held to 20 micro-inches R.M.S. or less, the resultant coated abrasive finish from a 50 or 60 second operation will be from 2.5 to 4 micro-inches R.M.S.

Similar in design to crankshaft lapping machines, camshaft lapping machines finish all bearings and cam contours simultaneously, using coated abrasive as the lapping medium. Either type of machine can be arranged for hand or semi-automatic operation.

The bearings are finished by laps similar to those used on crankshaft lapping machines. Contours are finished using a rounded nose-piece support for the abrasive. A master camshaft controls the motion of the laps so that the pressure is uniform throughout the revolution of the cam.

Camshafts are hard and if the profilometer readings on ground cam contours and bearings are held to 20 micro-inches R.M.S. or less, the final readings after a 30 second lapping time will be from 2½ to 4 micro-inches R.M.S.

Crankshaft and camshaft lapping machines are arranged with a reciprocating feature which effectually breaks up and eliminates the marks left by grinding.

Historical Interlude

Let us now go back to about 1920 when the early demands were made to finish parts such as automobile piston pins to such surface qualities as would resist wear. At first this was accomplished in remodeled drill presses. In 1922 Sidney Player and Joseph Bethel went into business as the Bethel-Player Company, producing lapping machines for round and flat work. This was the first company to market commercial mechanical lapping machines.

Norton Company acquired the Bethel-Player Company in 1927 to amplify their line of production precision grinding machines. Since 1922 hundreds of lapping machines have been sold all over the world to aid in producing parts and machines that will last longer and perform better and with less attention and care than ever before.

Just as lathe operations were supplemented about 40 years ago by precision grinding machines to produce round parts with better finishes and to closer limits of accuracy, other operations have been supplemented by lapping machines within the past 20 years for the same improved results.

Grinding was a means to produce better results for finish and accuracy on soft materials, and as the only means on hard materials, and at essentially lower costs. During the past few years lapping has supplied the step beyond grinding for the same reasons.

Surface Finishes Less than 5 Micro-inches

Lapping by any of the various methods will usually produce surface finishes less than 5 micro-inches R.M.S. Most good lapped surfaces read between 1 and 2 micro-inches R.M.S. Good average grinding is usually from 10 to 30 micro-inches R.M.S.

Diamond truing or facing on surfaces preparatory to lapping is about 40 to 70 micro-inches R.M.S. It is more open and will lap down quickly to good surfaces. In general it is suggested that surfaces which are to be lapped to any specified profilometer reading, be finished to not more than 10 times the final profilometer reading to be produced by lapping. The minimum and maximum profilometer readings on work prepared for lapping may range from 5 to 20 times the final profilometer reading after lapping, depending on the material, the machine and the method.

Experience on your own work is the best answer. It must be remembered that every type of machine operation is important as it affects costs. All operations and machining methods which are to be discussed here tonight are finishing operations. Other machining operations will precede them in your plants, and we emphasize that intelligent combination of operation sequences and sensible limits for size and surface finished are what create the results you all want.

May I remind you that there are several types of working surfaces that may be produced by lapping machines as follows. Each has its separate problems and methods of attainment.

1. Wearing surfaces which have high relative motion with other surfaces. These must resist wear.
2. Dimensionally accurate parts such as gauge blocks, plug gauges, etc., used with relatively little motion or speed, but which must remain accurate for long periods.
3. Non-wearing surfaces which must be flat, such as sides of ball bearing races to facilitate generation of races in accurate plane.
4. Spacing collars with no movement on the mating surfaces.

One of the most interesting and unusual lapping jobs is to produce dice which are smooth and which are extremely accurate cubes. All high priced dice gambling requires perfect dice, which are cubes accurate to less than 1/10th of a thousandth. This is a strange field for accuracy but we have satisfied the customers—at least with the equipment, if not with their personal results.

Standard Designation of Surface Roughness

A national committee has practically completed the preparation of a standard designation of surface roughness, and a list of surface standards in micro-inches R.M.S. The development of the profilometer makes it possible to give surfaces a definite value in shop production and to work to those values.

We believe that in the future all quotations from micro-lapping machines should and will include both production figures and the surface finish values which can be secured.

Our summary remarks about lapping are as follows:

Refinements of dimensional accuracy and surface finishes which have developed from the needs of industry for improved products should be considered by all who design and make any kinds of machines.

Limits for accuracy and surface finishes are the cumulative results of successively finer machining operations.

Dimensional accuracy and fine surfaces are mutual requirements.

Fine limits are possible only in conjunction with smooth surfaces.

Mechanical lapping makes possible high rates of production on refined machine parts at reasonable costs.

MEASUREMENTS OF SURFACE FINISH

By DR. E. J. ABBOTT, President, Physicists Research Company

These advances which you have just heard about means of producing finishes put very severe demands upon means of measuring finishes. The ability to produce and the ability to measure always go hand-in-hand. Sometimes the measuring gets a little bit ahead and then someone says, "What in the world do you fiddle around trying to measure those things for? You never could make them anyway."

Just as frequently the ability to produce gets a little bit ahead and then people say, "Why in the world do you fool around measuring that? We can build finer surfaces than that. We don't need to measure that."

But time and again it is found that measurements and production go hand-in-hand, each one helps the other one as a great team. We learn how to produce very much better if we know what we have. The measurements are better if we have some definite thing to measure.

Measurement of Surface Involves Many Characteristics

Now the measurement of surface quality is a tough job. It involves many characteristics of the surface. The characteristic which has been most fruitful of measurement has been the measurement of the dimensions of the irregularities of the surface and, as Mr. Weaver said a while ago, those measurements are measured in inches, or more conveniently, micro-inches.

These measurements of surface irregularities are far from simple. The biggest difficulty is the extremely minute height of these irregularities. People manufacture some very smooth surfaces. Just about the time we think we can measure as smooth a surface as anyone has produced they bring us another one about five times as smooth as the last one.

We have need for two sorts of measurements. One is a rather rapid and convenient one that can be used in the shop. Obviously that cannot be a complete story of the surface when we just don't have time. But, we do need a measurement which can be made and which will bear a reasonable relation to the use to which the surface will receive. You'll read more about that type of practical measurement a little further on.

There is another kind of measurement, though, that is just as important and of which we are learning a great deal more. That is a more detailed study of the surface. It takes more numbers and we learn a lot more about our surfaces if we investigate them a little more thoroughly than can be done with any single number.

Investigating More Thoroughly

If you were to examine a photomicrograph of a typical ground surface you would see a group of scratches of varying widths and varying lengths. When you examine the irregularities and scale off typical places, the widths would seem to run from about .0002" to about .0015". The length of the scratches would range from .001" to .050".

The approximate number of irregularities per square inch would be in the neighborhood of half a million. It would be impossible to take individual and personal measurements on each one of the irregularities present in even a square inch of surface. So the thing to do is to pick typical irregularities and measure typical average dimensions. Of course, there are times when there are individual scratches which are important from the standpoint of the fatigue, but the practical shop measurements which I talked about a moment ago of necessity must involve some sort of average measurements.

What Goes On Beneath the Surface

On the other hand laboratory measurements are inclined to lead us to study the dimensions of individual irregularities. However, we are not only concerned with the particular irregularities of the surface itself, but we are particularly interested in what goes on beneath the surface.

Mr. Wallace, in his paper has expressed that very well and I think perhaps our studies in the future are going to lead quite a bit to see what changes take place in the metal in perhaps a thousandth of an inch or so just below the surface. Sometimes changes may be improvements. Sometimes they may be detrimental. But certainly changes exist below the surface and the different sorts of operations have a great deal of influence on what those changes are. We must know more about those if we are going to be able to tell how our surfaces will operate.

By the same token we have to do other things to which Mr. Wallace has referred. That is just above the surface for a distance of perhaps one or two millionths of an inch. The researches of lubricating engineers indicate that a thin film lubrication is a matter of about a millionth of an inch in thickness; from there on down. And once a little oil has been placed on a surface it is impossible to remove that completely without removing some of the metal itself. It is fortunate for us that it is so or our lubrication problem would probably be far worse than it is.

So surface problems are going to involve not only the shape of the boundary itself, but what is on the surface and what is just below. We will know a lot more about that ten years from today than we do now. So much for the laboratory studies of surface finish.

Shop Methods of Measuring Finishes

Let's get back to our shop methods of measuring finishes. Several of the speakers before the A.S.T.E. Convention mentioned the "Profilometer" and I think you might like to know a little bit about it. So far as we know the "Profilometer" is one of the best means of measuring surface roughness in the shops today.

The business end of its "tracer" consists of a sharp diamond point which is sharp enough to penetrate to the bottom of the principal surface irregularities. The movement of the tracer is translated in electrical voltage through a coil. Surface measurements can be taken at any point where the tracer is placed. It can be moved by hand except on very smooth surfaces.

For surfaces that measure less than about 3 micro-inches it is better to move it mechanically. Surface irregularity readings go through a special vacuum tube, amplifier, and are read on a dial which is calibrated in millionths of an inch.

At first one might think that a diamond moved up and down over a surface would wiggle and that the meter should waver back and forth like a dial gauge does. In order to tell how big such a variation would be we made some studies in the laboratory, but I found that it was useless for this work. If we have a half million irregularities in each square inch, and if we waited for the needle to go up and down, a reading would take even longer than a Convention Session.

Rapid Observations Only Practical Method

So the practical thing is to have a device that will take observations rapidly, 500 or more, possibly a thousand, per second. But you can't observe such rapid variations visually. So the meter must remember the several hundred it went across and measure them up and give you that number. It makes no attempt to measure individual irregularities because that would be too slow for shop use. It does give the average height of the irregularities measured in millionths of an inch.

The "Profilometer" can be used on cylindrical work as well, either internally or externally, by adjusting the height of the diamond. Or it can be used to measure the inside of any hole big enough to admit the tracer.

With the "Profilometer" various people can get the same reading and it serves as a common language for discussing the quality of surfaces. This is by no means a complete description of a surface, but only a measure of the average height of the irregularities.

If one has a ground surface and another surface where irregularities criss-cross, look entirely different and operate differently it is necessary to take into account the character of the irregularities. That can be done by laboratory studies, but this is one measurement which goes a long way toward getting the problems of a surface finish on the numerical basis which we have long needed and which have already proved of great value in the progress which has been accomplished.

NEW DEVELOPMENTS

and Their Effect on the Tool Engineer

C. H. BORNEMAN, Chairman, Supervisor, Tool and Gage Service Department
General Electric Company

GEAR TOOTH FINISHING

By R. S. Drummond
National Broach & Machine Co.

Mr. Drummond: In considering finishing of gears, one has to differentiate between different classes of gears because the treatment given to automobile gears is quite different than that given to gears for precision machine operation. It is equally different than the treatment given to machine tool gears.

Today a very large percentage of gears in this country are being lapped after hardening instead of ground. Due to improvements in steel and methods of manufacture, it is possible to process gears right through heat-treatment and have them sufficiently accurate for commercial use. We have reached this stage on a few installations where great care is used throughout the manufacturing process.

As manufacturers of lapping machines, we feel that within the next 10 years, the production of that type of machinery for commercial gears will be reduced because we are making very great strides in the preparation of gears before heat-treatment and the handling of them through heat-treatment. A study of the changing of gears through the heat-treatment has proven that there is a normal change through a given heat-treatment properly executed, which can be depended upon. In many plants a definite amount of allowance is made for heat distortion which permits 80% of the gears to come through heat-treatment with uniform variation. One large manufacturer uses no finishing process whatever after heat-treatment except that of ordinary cleaning and is successful on many thousands of gears per day.

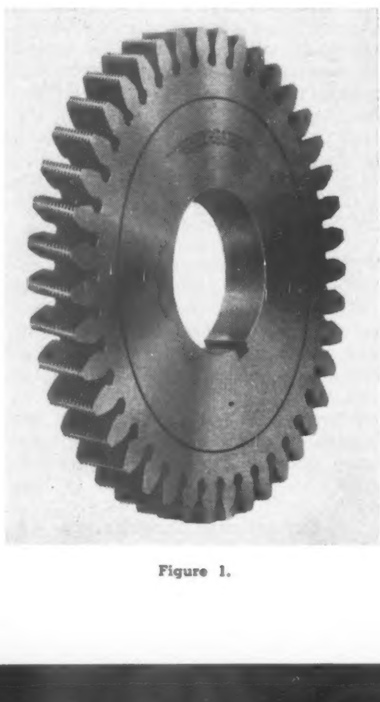


Figure 1.

Another influence on the finishing of gears is in the roughing operations on the gear teeth. Heavy cutting on the gear sets up strains in the surface of the teeth which bound out when relieved by heat-treatment. The amount of distortion varies with the compression due to cutting. In some cutting operations, we have seen as much as 5 or 10 thousandths of distortion due to roughing or rough cutting of teeth. We have also seen cutting done which has a uniform distortion affect of a couple of tenths which can be allowed for.

Of late years, a large part of the production of automobile parts has been done with a final operation of gear shaving. (See Fig. 1.) In this, a very accurate tool, customarily made to 2½ tenths accumulative error is used to rotate and cut the gear while on centers. This tool guides the work, shaves it, and removes sufficient material from the surface to relieve the strain from the roughing operation.

This is a rotary cutting operation in the path of travel with the gear. It requires a little extra clearance at the bottom of the teeth so the tool cannot wedge in the root of the teeth and abruptly cut the surface. The tool usually has a hunting tooth construction so the same tooth on the cutter does not normally contact the same tooth on the gear. It is a generating process, starting at one side of the tooth and generating across the tooth on the other side. Many inaccuracies previously present in the cut gear before heat-treatment, have been eliminated. Distortion due to the compression of the tool and the distortion due to tool errors in the gear, have been greatly reduced by this process.

A word further about finishing and with particular reference to grinding and lapping; many gears are ground, particularly those of larger diameters. It has been found that the gears going through the hardening process, which are finish shaved before carborizing, have less distortion. It has also been proven that the time element of finishing can be greatly reduced by using the grinding process to remove the larger errors but not taking the time to spark out, which is such a long process. Thus on a gear of about 12 inches diameter and an inch and a half face, which frequently requires an hour and a half of finish grinding, it is possible to give this a rough grinding operation of 10 or 15 minutes and bring it within lapping limits and then finish it with 5 to 7 minutes of lapping. This practice greatly reduces the cost and has the advantage of giving a rounder condition to the gear which is better for running conditions as the gear has been run with a lap as a rotary mating gear.

In finishing gears it is important that the type of steel and heat-treatment be considered as it is normal for cyanide gears to grow through the heat-treatment, such as 4645 steel, and it is customary for carburized gears to shrink in tooth form as in 4615 steel. An allowance for this change can readily be made in the shaving process so that this error is readily compensated for.

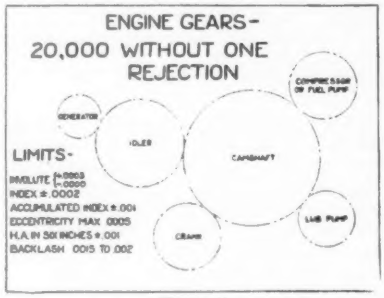


Figure 2.

Fig. 2 shows the limits of manufacturing of timing gears which are made to run metal to metal. This set of six gears has been produced up to a total of 20,000 pieces without rejection. The gears were held within the limits indicated in order to obtain this favorable result. It was necessary to make a 100% inspection of all parts.

The Shaving Process

We discuss now the shaving process for your better understanding. The contact between the cutter and the work is greatly reduced because the two parts are set at an angle to one another. This reduction of contact is similar to that of two parallel cylinders that are turned about to cross each other at an angle. This reduced contact would shave a curved surface in the mating part if the part is not reciprocated and it is, therefore, desirable to start the cutting action at one side of the gear and generate across its face.

In the area of contact between the shaving cutters and the gear, the outer blades cut to a lesser depth than the center blades so that the center blades are relieved of considerable wear, the outer acting as semi-finishing edges.

Another interesting feature is that the contact between the gears, when the cutting takes place, is not parallel with the gear axes but up the tooth, gen-

(Continued on page 52)

GAGES

By CLINTON V. JOHNSON, Engineer
Pratt & Whitney Division, Niles-Bement-Pond Company

I BELIEVE that even the most casual observer at this Machine and Tool Progress Exposition will cheerfully concede that the development of gages, the tools for determining dimensional accuracy, has certainly kept pace with the steady and remarkable advancement which we all realize has been made in both the Machine and Small Tool fields. Gages are the tools by which accuracy is measured and, in so doing they analyze the suitability or limitation of the manufacturing equipment—the machine and cutting tools—and also measure the ability of the operator to perform the task required of him. The constructive criticism rendered by gages is frequently the forerunner of improved machine and tool construction, and improved manufacturing methods as well. Obviously, gages have important indirect functions to perform.

Those of us who have a more intimate contact with both gage manufacturer and gage user frequently hear that gages tell entirely too much, that they are super-critical, that they create unnecessary manufacturing problems and resistance. But these situations, as the experienced and informed Tool Engineer realizes, simply indicate a misunderstanding and a misuse of gages. The reference that has been made to the advancement of gages does not indicate that the gage manufacturing industry has arrived at a state of self-sufficiency or to an attitude that the ultimate in gage development has been attained. On the contrary, there is a steady and vigorous research activity; and a continuous effort to develop better materials and harness the elements of light, air, electricity, etc., to provide the gages needed—or, to put it more accurately, to anticipate the requirements of our forward moving industry for even more efficient gages and methods of gaging.

Before discussing the effect which new developments in gages is having on the Tool Engineer, I believe it necessary to first consider the reason for these developments; and, secondly, enumerate some of them. There are, in my opinion, four prime reasons for gage development. The first is technical, the second economic, and third a changed and corrected conception of the true purpose of gages, and lastly humanistic and humanitarian influences.

Technical Influence on Gages

The first mentioned reason for new developments in gages is the technical influence. The rotary type unit in mechanical refrigerators, fuel injectors for Diesel motors, the rapidly increasing complexity of gunfire control military equipment, for instance—much of which is radio responsive and actuated, are examples of the comparatively newer products which make unprecedented demands for greater operating efficiency, endurance, quietness, precision of operation, etc. Besides, the more mature industries such as the automotive, the machine tool, and others, are no longer satisfied with the standards of precision that were at one time acceptable. In other words, the functional requirements of many new and old mechanisms demand much greater accuracy. In addition to this, there is increasing competition within most industries, and it is recognized that survival and success hinge largely on quality of product. We all realize what a tremendous influence gages have over the accuracy and quality of the product they check—they are frequently referred to as management's guardian and the customer's representative.

Summarily, the technical reasons for gage development are: new products, refinement of old products and the increasing severity of competition—based on quality—within an industry. All this reduces itself to a common point—a definite need for greater dimensional accuracy and control. To obtain this, gages that are new in appearance, new in design and principle, and new in method and place of operation are required.

Economic Influence On Gages

The second mentioned reason for new developments in gages is the economic influence. If a favorable competitive position is to be obtained and maintained for a product, it must be "in line" on price. Selling price has one very important element, namely, cost of manufacture, and this embraces among numerous others, machining, inspection, and assembly costs. It is unnecessary to state to this well informed group that gages and gaging methods have a decided influence on the cost of manufacture; and it is hardly necessary to explain that this recognized influence of gages or manufacturing cost results in a constant demand for gages that will last longer, be faster in operation, assist the machine operator to greater productivity, and prevent spoilage of work. It is increasingly recognized that a concern cannot compete in business today with yesterday's gages if it wants to remain in business tomorrow.

The True Purpose of Gages

The third reason for new developments in gages is because of a changed and corrected conception of the true purpose of gages. A commonly held definition of a gage even in the recent past, and still held though by fewer and rapidly diminishing numbers, is as follows:

"A gage is a device for determining accuracy and interchangeability." With this interpretation it is obvious that its usefulness is definitely restricted to a mechanical function. Its influence extends to the quality of the product only; the equally important price angle of the product is entirely overlooked. Under this incorrect definition, the gage is simply a tool with which to conduct a post-mortem examination—to accept or reject the product after it is made.

A Changed Attitude Toward Gages

However, the attitude toward gages and their purpose has changed; the economic as well as the technical function is now considered and a reconstructed definition of a gage is as follows: "A gage is a device to facilitate production and guarantee quality." This revised definition of the purpose of gages broadens their scope of utility—the gage becomes a partner and intimate neighbor to the machine and small tool to facilitate production, and, at the same time, retains control and responsibility for the accuracy or quality of the product. This suggests what we commonly refer to as "working" gages, gages to be used at the point of manufacture where they are available for the machine operator. Not only are they to be available and conveniently located for the machine operator, but they must further facilitate production by telling the operator the whole story about the job he is doing; that is, the gage must sufficiently analyze the operation, reveal the nature and degree of error, if there is an error, so that necessary machine and tool adjustments can be promptly made when required. The ultimate, of course, is to have gages actually operate and control machines.

The need for analytical working gages, caused by the changed and corrected conception of the true function of gages, has naturally brought about developments and improvements in gages. Not only have these working gages involved new designs to provide the necessary analytical features, but the ingenuity of the gage designer has been taxed to provide gages that are sufficiently rugged to withstand normal machine operator, coupled with his lack of inclination to "nurse" his gage this gage must operate with all possible freedom from such variables as the "human element" i.e., they must be "alibi proof." With these qualities built into the working gages there must also be incontestable accuracy so that parts produced and accepted by it will pass any and all subsequent inspections. This is absolutely necessary if we are to develop and maintain operator confidence in gaging equipment, engineering specifications for tolerances, etc. These requisites for "working" gages have resulted in modifications and improvements in conventional designs and have brought about many new styles and types. Therefore, it should be clear to all that the changed and corrected conception of the "purpose of gages" has contributed greatly to their development.

A Humanitarian Consideration

The fourth reason for new develop-

(Continued on page 54)

CUTTING TOOLS

By L. C. GORHAM, President, Gorham Tool Company

IT IS particularly appropriate that a meeting called to consider the effect of new developments on the profession of tool engineering be convened here in Detroit, the seat of the automotive industry. No other industry is quite as anxious to have tomorrow's production completed yesterday. This demand for the speedy, economical, production of parts has led to many interesting improvements in machine tools with consequent improvements in cutting tools. It is apparent that high labor costs are here to stay. If the costs of production in any industry are to be kept at low levels, full advantage must be taken of the possibilities offered by the use of new designs and new materials in cutting tools. Those of us who are interested in tool engineering, no matter what our particular field may be, are in a favorable position to make use of these new developments in holding production costs to a minimum.

It is impossible in the allotted time to bring out much concerning new designs of cutting tools. Just as special purpose machinery has largely displaced standard types on production jobs, so cutting tool designs have been developed for specific applications. We no longer have to go through a "Cut and try" experimental period to develop tool shapes when confronted with the problem of machining some certain part. The data from past experiences dictates just what type and shape of tool should be most satisfactory and, beyond that information, there is usually very little alteration required to complete the design of a cutting tool. We are realizing more and more that the art of cutting anything follows basic rules of chip formation and disposal and that the design of cutting tools is nothing more than the adaptation of these basic rules to suit the machine tool and work involved. We are greatly indebted to such men as Hans Ernst and Professor O. W. Boston for their work on the physics of cutting. Such information is the answer to cutting tool problems; if we can develop a satisfactory cutting edge design, the design of the balance of the tool is usually comparatively easy. New ideas, such as the recent broaching or rotary milling developments test the design ability of cutting tool experts but these problems are fundamentally those connected with economical chip formation and disposal. If your design permits the cutting of a reasonable chip with a minimum of power consumption and provides ample chip room to adequately clear the tool, you have the elements of a good cutting tool. Provide a simple, effective, means of driving or clamping the tool and your design is complete.

Until recently, it was felt that a tool engineer should be content to design a cutting tool and let the tool maker worry about the material to be used in making the tool and the physical characteristics needed to satisfy the application. This laiss ez-faire attitude paved the way for "passing the buck" between the tool designer and the tool maker. Where the same tool is purchased from different sources it is essential for equitable pricing that the material to be used in the tool be specified and that vendors be rigidly held to such specifications. Whether the cutting tools are made in our own plants or purchased on the outside, satisfactory performance can only be realized when the tool material is that which has been found to be best for that particular job. This means that all cutting tool prints or requisitions for standard shapes should specify the class of material to be used in those tools. With a little information on this subject, the average cutting tool designer is better equipped to do tool material specifying than the average metallurgist because he can visualize the working conditions of his brain child and demand the use of a material that will permit his design to produce as he intended.

When we consider the types of material available for cutting tools we find three distinct groups: the High Speed Steels, the Stellite types, and the Cemented Carbides. The applications on which carbon or alloy tool steels make successful cutting tools are so few that it is not a grievous omission to leave them out of this discussion.

The High Speed Steels may be classified into two basic divisions by the major alloying element entering into the composition, Tungsten or Moylbdenum. Under these two basic divisions come the various analyses of Tungsten High Speed Steels alone. These differ in the conclusion and amount of the minor alloying elements such as Vanadium, Cobalt and Chromium. It becomes a serious problem to "The Tool Engineer" when he is called upon to specify the proper material to be used on his designs because, in many instances, tools made of the higher priced steels are most economical on production runs. When we realize that the base price of Tungsten High Speed Steel has a spread from sixty-seven cents per pound to two dollars and forty-two cents per pound, it is plain that great care must be taken in choosing any analysis for use in a tool to achieve the most economical results.

The most common and generally used Tungsten High Speed Steel is the 18% Tungsten, 4% Chromium, 1% Vanadium analysis, usually designated as 18-4-1. This type has been so generally used for thirty-five years that tool engineers have been content, when designing cutting tools, to merely specify "High Speed Steel" with the intention of having the 18-4-1 analysis used. There are mechanical limitations to the use of the 18-4-1 that did not become of great importance until the advent of tougher and harder production steels. Then it was discovered that tool life of 18-4-1 tools was too short when used on certain difficult operations and tool steel manufacturers introduced High Speed Steel analyses with higher alloy content to increase the red hardness, toughness, and abrasion resistance to make possible the economical machining of these new materials.

Since Vanadium adds abrasion resistance to High Speed Steels, many experiments were conducted on analyses containing more than the old conventional 1%. Out of these trials came the 18-4-2% and the 18-4-3¼% steels. Both of these have distinct advantages and are widely used at present on operations where the slight additional cost over 18-4-1 is warranted by better performance.

Cobalt is added to High Speed Steels to increase the red hardness; that is, to give tools the ability to stand up even when the heat of cutting reaches the point at which the cutting edge is at red heat. Soon after the discovery of this influence of Cobalt additions, various analyses of Cobalt bearing High Speed Steels were marketed. Three of these have stood the test of time in spite of the increased cost of the Cobalt addition. They are the 18-4-1 plus 4% Cobalt, the 18-4-2 plus 8% Cobalt and the 22% Tungsten, 5% Chromium, 1½% Vanadium, 12% Cobalt analysis. This group is interesting because the base prices of these steels are much higher than the 18-4-1 and yet they are the most economical tool materails on certain heavy duty applications. The last mentioned type with 22% Tungsten and 12% Cobalt is the highest priced High Speed Steel marketed today. It was originally developed for use on machining high manganese railroad track sections and other such jobs on which all other cutting materials were ineffective. Although more recent developments in the molybdenum steels are practically as efficient, there are still some places where the two dollars and forty-two

(Continued on page 62)

HYDRAULIC UNITS

By F. T. HARRINGTON, Vickers, Incorporated

The subject of this discussion, "Hydraulics Applied to Machine Tools and Fixtures" is a rather broad topic to be covered in the period of twenty-five minutes assigned by your program committee, and we shall therefore have to limit our discussion to the general types of pumps and controls of our manufacture with which we are most conversant, and their uses. The merits of hydraulic oil power as a means of actuating all types of machinery are today generally recognized. One can find applications in almost every phase of mechanical endeavor. The art has progressed down through the years from such uses as operating elevators; heavy, slow moving presses; and steering ships; to the modern refinements such as feeds and drives for machine tools, positioning the elements on mobile equipment such as road machinery, industrial tractors, and mine machinery, and supplying the power to aircraft controls such as the Sperry Automatic Pilot.

The essential parts of a hydraulic system are the pump, the motor, and the controls.

The principal element is the pumping unit, or power generator. These may be classified generally into constant and variable delivery types, both of which have their fields of usefulness.

We have some slides* to illustrate the design and application of such units, many of which are displayed, and some in actual operation at our customers' as well as our own exhibits here at Convention Hall. We shall not attempt to go into detail in describing the applications, but are using these to hurriedly show the diversity of machines to which hydraulic controls are applied.

(Slide) This illustrates a constant delivery balanced vane pump, which is designed for applications requiring pressures up to 1000 lbs. per square inch. This shows an external view of the unit as well as the one with the head removed exposing the internal assembly, which consists essentially of a rotary element with vanes operating against a ring of special contour and carried on two bushings which also form the valves. The next slide illustrates the internal construction more thoroughly.

(Slide) This indicates the construction of the unit. We note the rotor assembly is carried in two bronze bushings and the vanes follow the contour of the ring in such a manner that as they are passing from the suction to the discharge ports, they do not move radially but move on a true circle arc with reference to the center of rotation. The principal feature of this pump, as compared to the other constant delivery pumps on the market, is the balanced pressure construction. It will be noted that the suction ports are carried around to diametrically opposite sides of the rotor and the discharge ports, likewise, are carried to diametrically opposite sides. This provides equal areas of high pressure on both sides of the rotor so as to balance out the tendency toward high bearing thrusts. In other words, the hydraulic thrusts, applied against the sides of the rotor are balanced.

(Slide) The applications are quite varied. This slide shows some broaching machines on which the vane pump and suitable controls are used. One happens to be a surface broaching machine of which there has been considerable development, during the past five years, and the other is a spline broaching machine for transmission gears. The vane pumps are applied on these machines in sizes up to 60 gallons per minute and the working pressures 1,000 lbs. per square inch.

(Slide) This illustrates a honing machine where the spindle and tools are reciprocated hydraulically by a suitable cylinder and vane pump. The controls, of course, are pilot operated to obtain rapid reversals and variable speeds of reciprocation.

(Slide) Another application is to surface grinders of different types. This shows a relatively small surface grinder where the table is reciprocated by power furnished by one of the small vane pumps.

(Slide) This illustrates a larger similar machine for grinding shear-blades as used in steel mills. On this particular machine, the vane pump and speed controls are placed in the tank on the left, and a suitable pilot valve controlled by trip dogs governs the stroke of the table. These machines are made with strokes up to 18 feet in length.

(Slide) Another application is to various types of open side planers and shapers. An open side planer is illustrated here, the pump furnishing the power for reciprocating the table, for intermittently cross-feeding the tool on the rail, for rapid traversing of the tool slide for set-up purposes, and for rapid traversing of the rail on the column of the machine.

(Slide) Another field in which these vane pumps have been used quite extensively is road machinery, on which the pump is mounted on the power take-off of the engine or transmission. By use of suitable valving, it is possible to actuate plows, hoists on bodies, or similar controls.

(Slide) Applications in the fire fighting equipment field include aerial ladders, where the pump supplies the power for the stabilizing jacks under the frame, to the elevating jacks on the ladder, for operating the winch which runs the ladder out, and for rotating the turn-table which carries the ladder. All these functions are supplied by a single source of fluid power.

(Slide) The vane pump is also built into an assembly which we term a combination pump, designed for applications where a large volume of oil is required for low pressure portions of a cycle, and a smaller volume for high pressure or feeding portions. This consists substantially as shown diagrammatically here, of two pumps of the thousand pound vane type, driven by a common shaft and mounted in a single housing. In the left-hand diagram you will note that both pumps are operating in parallel. This is the low pressure cycle. The right-hand diagram illustrates that after a pre-adjusted unloading pressure is reached, the large pump merely circulates while the small pump supplies the oil necessary for feed or to maintain pressure, as in press operation. The unloading feature is accomplished entirely by pressure increase in the system being supplied.

(Slide) In the machine tool field, this pump is used on drilling and reaming machines as illustrated by this vertical, multi-spindle machine. The large volume of oil is available for rapid approach and return portions of the cycle and the small volume at high pressure, during the feeding portion. A suitable control panel permits an automatic cycle consisting of advance, two feed rates, rapid return, together with the possibility of delayed reverse. Push button control is available for starting and also for reversing the head in the event of tool breakage.

(Slide) This is another application where the same style of pump is used on a cylinder block cam and crankshaft boring machine, one pump being used in the roughing stage and another pump to control the semi-finishing and finishing stages of the machine. The operator loads the block into the roughing station and by pushing a button initiates the cycle which consists of first transferring the block into the fixture. The block is elevated hydraulically in the fixture to the cutting position against suitable locating pads. The feed cycle automatically starts, consisting of rapid advance, feed in one direction, rapid return, feed the other direction, and rapid return to the loading position. At the completion of the feed cycle, the block is automatically lowered in the fixture, and the cycle duplicated. The operation of the three machines is controlled from one loading station and on this particular machine, electrical interlocks are used to insure proper sequence of the various functions. On some of the machines hydraulic interlocks are used, and the block transferred from station to station by suitable cylinders.

(Slide) This illustrates a pump of this type applied to a plastic injection molding machine, as used in an art which has made rapid strides during the past three years.

* Mr. Harrington's discussion was almost entirely devoted to an explanation of many slides which were shown. Owing to the impracticability of illustrating these slides, only a description of the more important slides can be given here.

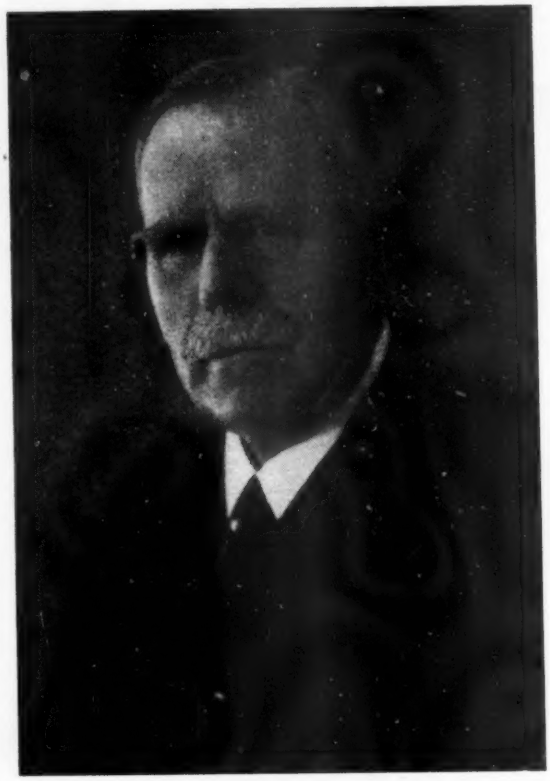
JOHANSSON, FATHER OF MASS PRODUCTION

Honored on 75th Birthday

CARL Edvard Johansson, variously known as the World's Greatest Toolmaker and the Father of Mass Production, was honored by the Detroit Swedish Engineering Society, February 28th, when the Society presented an inscribed bronze plaque commemorating the scientist's 75th birthday (March 15th). Mr. Johansson, who has advanced the science of measurement to a precision previously unknown, produced the first set of metric gauge blocks in 1896, has since refined these blocks to a plus or minus tolerance of a millionth of an inch, and lately obtained international acceptance of a gauge block 25.4 millimeters in length—now the accepted conversion basis of the scientific world—as the metric equivalent of the inch. For his outstanding contributions to industry and civilization, the inventor has been signally honored by awards and degrees in various lands, has been the recipient of the ribbons of high orders in his native Sweden.

The value of Johansson gauge blocks, now recognized as a world standard of measurement, became readily apparent to Henry Ford, who saw that they presaged a new era of accuracy in mass production. As a result, Ford Motor Company obtained manufacturing rights for the Western Hemisphere. Mr. Johansson and associates came to Dearborn in '23, where a modern laboratory for the manufacture of the blocks was put at his disposal. It was there that he evolved the 25.4 standard, which assures manufacturers in all lands that their precision-made parts conform to identical, rigid standards of measurement.

The plaque was presented to Mrs. Gertrude Tufford, daughter of Mr. Johansson, at a special testimonial dinner, Tore Franzen, president of Detroit Swedish Engineering Society, presiding. The inscription on the bronze plaque reads: "To The Honorary President Mr. C. E. Johansson—The Society expresses profound appreciation of your great achievements in science and industry and extends sincere congratulations on the 75th anniversary of your birth." In presenting the plaque and a scroll signed by the members to Mrs. Tufford, he gave a resume of the scientist's life and proposed that the Society establish a Johansson medal to be awarded each March 15th to "someone in the engineering world who rightly deserves such honor." Mrs. Tufford responded on behalf of her father and promised to present plaque and scroll in person during the birthday celebration to be held at Eskilstuna, Sweden, March 15th.



Carl Edvard Johansson, whose invention of the "Jo Blocks" so familiar to Tool Engineers throughout the world, made practical interchangeable manufacture.

Photo—Courtesy Tore Franzen

Mr. Johansson, in an informal pose on his last visit to Detroit, with A.S.T.Eers John Markstrum (Left) and Otto Lundell (Center).

The plaque, which has a border of simulated Johansson gauge blocks around the central inscription, was designed and constructed by Sten Jacobson, rising Swedish sculptor formerly with Cranbrook Foundation and latterly instructor in sculpture at Wayne University.

We feel that this award is of especial interest, not only to the engineering and industrial world (see "The Tool Engineer" for May, 1935.—p. 11), but to the American Society of Tool Engineers. Mr. Johansson has, personally, been a powerful force for progress in Tool Engineering, and the Detroit Swedish Engineering Society includes men who have been active in promoting the A.S.T.E., as committee workers and as contributing writers to "The Tool Engineer." We share vicariously in the pleasure of the award and congratulate our Swedish confreres upon so signally honoring their Honorary President.

Concluding, we quote the graceful, closing paragraph of Mr. Franzen's speech: "Simple it is indeed when compared to the capes and laurels which learned societies have conferred upon him. Simple in comparison to the John Ericsson medal presented him by our brother society, the Swedish Engineers' Society of New York. Simple when compared with decorations which he has received from kings and potentates, but in all its simplicity, no sentiment could be more sincere. Give it to him, with our well wishes. God bless you. Halsa Hem."

CHAPTER DOINGS

By GEO. J. (Jitter) KELLER

THE second show has come and gone. It was bigger and better than the first. It will linger long in my memory because I saw many beautiful exhibits, learned much and renewed many old acquaintanceships. What more can one ask? Roaming down thru the aisles I stopped here and there to greet such fellows as: Jack Lovely, Eddie Brandt, Jack Hawkey, Eddie Prange, Tel Berna, Gene Batchelor, Chris Borneman and Good Old D'Arc from Hartford. Oh—what's the use—I could write a book about the guys I saw. Then there was the annual dinner with the wonderful introduction by Homer Bayliss of a wonderful guy, Detroit's own Bill Stout. A swell dinner, a good speaker, and last but not least an interesting and enjoyable "technical Session." Well, I guess I better quit my rambling and get at the job I'm supposed to do.

Let's head the list with **Elmira,** our new Chapter No. 24 which was founded on February 17th by 60 plant executives and Tool Engineers at Hotel Langwell. The dinner was sponsored by Ray Neal of Buffalo and representatives were present from 20 plants in this district. The chapter was chartered with 25 new members and 7 who were transferred from distant chapters. The officers are: Chairman, John R. Lynch, Athens, Pa.; Vice Chairman, Ray Blank, Painted Post, N.Y.; Secretary, Howard E. Strattan, Elmira; Treasurer, James R. O'Connell, Elmira. The second meeting of this chapter was held on Friday evening March 10th and Mr. Ralph E. Flanders, President, Jones and Lamson Machine Co., spoke to 55 members and guests on "Thread Grinding, A New Machine Shop Practice. At this meeting all plans for the trip to Detroit were made.

The annual social get-to-gether of **Hartford** Tool Engineers was held on February 17th in Sangerbund Hall. 200 members and friends gathered for a good dinner, an opportunity to pop-off and a jolly good time. Everyone made the most of it. The March meeting was a dinner and business meeting held at the City-Club. New officers were installed. Policy and plans were discussed with Ray Morris as Chairman. Messrs. Banks and Libby were present giving the situation the once over with the view of organizing a chapter in Worcester. After the dinner everyone adjourned to the Gas Company Auditorium and were interestingly addressed by Mr. R. O. Beardsley of the Jones and Lamson Machine Co. on the Industrial Application of the Comparator. Atta Boy, Bob. Didn't know you were a speaker. Don't become an orator. That leads to the Senate.

Along comes **Toledo** to tell us their annual dance on February 24th, was a big success in spite of the flu epidemic. Much credit goes to Walter Seeman and Lorence Rennell. A large and enthusiastic group turned out for the plant inspection trip at the Electric Autolite Co. Toledo Plant on February 14th. Claude Pound and Charlie Francis extended greetings to the boys. The guides for the trip were all active ASTErs. They, however, had some difficulty in keeping the group moving especially around those nice machines with the interesting feminine operators. The trip was followed by a discussion and refreshments in the cafeteria. Called on Charlie Francis years ago and will look him up the next time I am in Toledo. Heard in Detroit that you put Herb Tigges to work. That's good, boys. Ride him—that's what he does to me.

"House of Magic" demonstration was presented to **Schenectady** Chapter March 9th in Rice Hall to about 100 members and guests. After this demonstration two motion pictures on "Excursions in Science" were shown. Chris Borneman dispensed all the dope on the Progress Exhibition at Detroit. We know he did a good job because the showing made was very fine.

Two hundred members and guests gathered at the Midwest Athletic Club for the March meeting of the **Chicago** Chapter. An hour was spent looking at the various exhibits, then came the dinner. Wee Willie Smith entertained everyone. He did everything but play a harp. The tiny daughter and son of Mr. Croft added much to the evening with their songs and dances. King Cole announced the dance for April first. Sort of an April "Fool's" affair for members, guests their wives and sweethearts. The dinner dance is to be at the Midwest Athletic Club. Harry Fruehauf spoke briefly on the Detroit show giving all the information incidental to making the trip. Ad Kooyman introduced the speakers of the evening, Messrs. Carpenter and Emerick of Bethlehem Steel Corp., who presented a picture on the Golden Gate Bridge at San Francisco.

Baltimore gathered at Sears Roebuck Auditorium on March 13th and heard a very interesting talk by Mr. J. M. Fenlin of the Bakelite Corp. on Organic Plastics and their proper uses in product design. Mac says that the Tool Engineer who does not know his plastics is not abreast of the times. Chairman Johns was very much pleased with his new wooden hammer. May he wield it judiciously. Vice Chairman Van Sant and Secretary Steiner were conspicuous by their absence. Don't be too hard on them, boys. They were enroute to the mecca of all Tool Engineers, Convention Hall, Detroit.

Bridgeport had a swell turnout at the March 9th meeting. Geo. M. Class of Gisholt Machine Co. gave an illustrated address on turret lathe and automatic chucking machine tooling. At the request of Chairman Dundore Ben Page gave vent to his oratorical ability by presenting his views regarding the tool show at Detroit. Frank Whelan and Harold Carter sure have a super memory. They even know what Sally Rand wears.

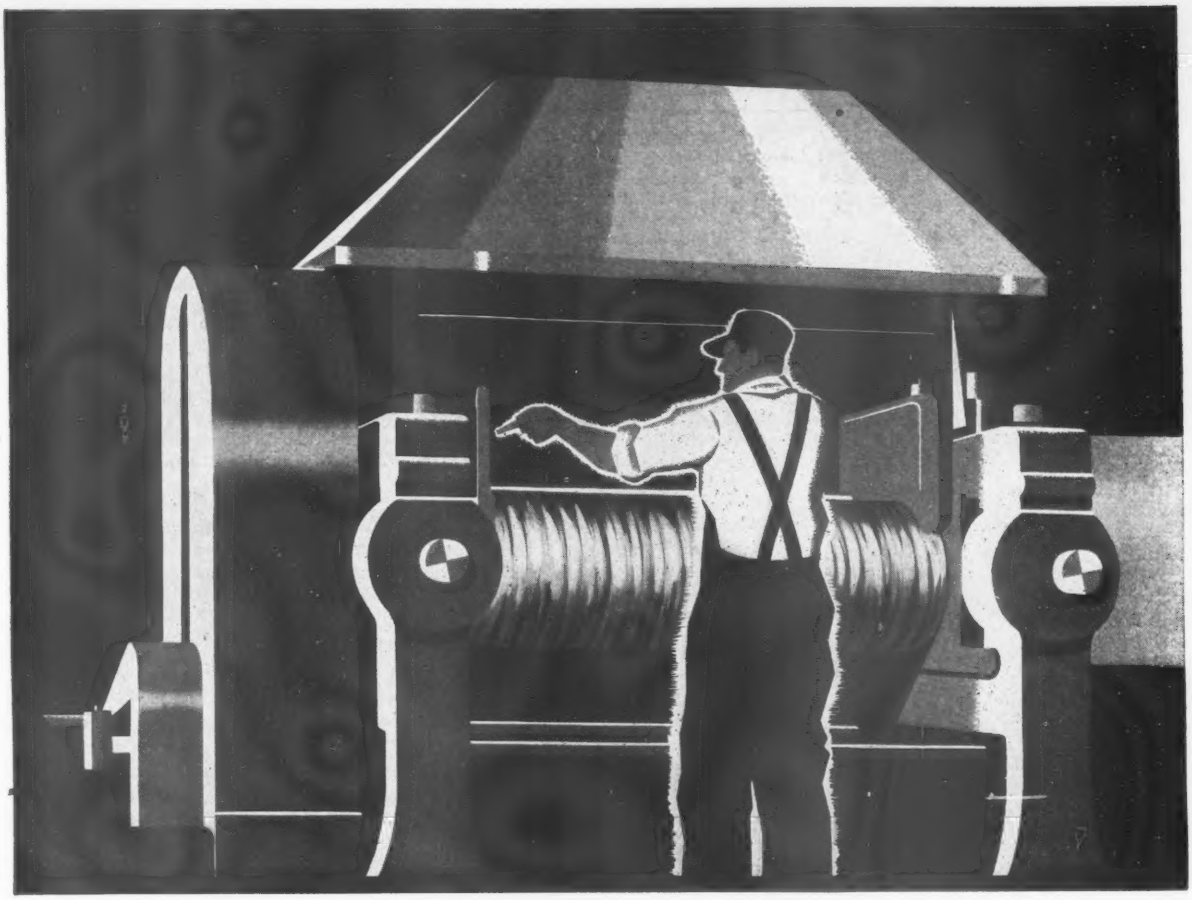
Syracuse had a special meeting on March 3rd. All the officers of the past year were re-elected. The trip to Detroit was discussed and might add that they did a swell job. One whole carload journeyed to Detroit in a group on March 15th. Mike Adams was the "man for an hour" on this trip, if you get what I mean.

February 16th meeting at **Detroit** was a grand success. 206 steak dinners were served and many more dropped in later to hear R. L. Wilcox and W. W. Broughton, New Jersey Zinc Co., present illustrated talks on Die Casting, The Modern Fabrication Process. The entire Club Saks belonged to the boys. There was an orchestra, music, floor show—and what have you. Bill Smila, Luke Beach, Charlie Staples and Joe Seigel were there. Your editor wonders if Joe gathered any ideas for the annual dinner. Charlie Theide, Chairman, S. K. Kuhn, Vice Chairman, B. L. Diamond, Secretary, Lawrence W. Howe, Treasurer, are the new officers for Chapter No. 1.

More dope on **Cleveland's** February 16th meeting. Geo. Smart started the question period off with a bang. In fact, some of the members believe he's part of the Information Please Radio Program. Gus Seelander and Tom Fraser finally got all the dope on making steel tubes. Gus was seen punching holes in erasers and trying to roll it into an inner tube. Rudy Harrold, the most eligible bachelor, brought his gang with him again. Bring 'em in, keep it up, let's have your recipe. Charlie Goetz has a new one, his Tobasco Sauce Stinger. Harry Sauers brought his boss W. H. Poesse with him. Here's hoping you enjoyed the meeting W.H. and that you'll come again. Bob Kiffer recently purchased the Lyons Machine Co. and all the boys wished him success in his new venture, The Kiffer Tool and Die Co. The U.S. Steel Co. did a wonderful job on the picture.

Rochester held their regular monthly meeting on March 7th. The all important matter of election was taken care of and resulted in the election of that golf playing, genial Master Mechanic Charles E. Codd as Chairman. In fact he was in Florida at the time following his favorite pastime. John Dense was elected Vice Chairman and that horse for work, Milton Roesel was re-elected Secretary and then had the Treasurer's job added to it. Believe you me if a guy's willing these tool engineers will

(Continued on page 62)



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PRODUCTION PERSPECTIVES

News of Mass Manufacturing from Everywhere

No magic or formula exists to remedy economic conditions in this country **but the same kind of hard work by which the nation originally grew to its high standard of living.** Dr. Leo Wolman of New York, one of the country's leading economists, asserted before the Cleveland Engineering Society at Guildhall the night of March 1. The real **job problem** may be defined as persistent unemployment **that continues on an unusually high level even in periods of prosperity,** according to Dr. Wolman, who is professor of economics at Columbia University.

Obstacles which the American economic system must overcome to remove the "core" of its ills, Dr. Wolman listed as follows: 1—Taxation and the general fiscal policy of an unbalanced budget. **2**—The attitude of the government toward private industry, especially competition with private industry, as in the case of private utilities. **3**—Labor policy, especially the question of wages. **4**—Relief policy, especially as it stops workers from finding their level in an open labor market. Citing England as an example, the economist said that in the period of prosperous years from 1860 to 1914 the ratio of unemployed to workers in England was only 4 per cent. Yet, in the 1922-1929 British period of prosperity, the unemployment rate was 10 per cent, while in England's 1933-1937 prosperity the rate was 13 per cent, he said. The United States' unemployment rate in the prosperous years of 1934 to 1937 was 15 per cent, only 4 below the rate for the depression years of 1930 to 1933, Dr. Wolman added. **The doctrine of stimulating purchasing power by public spending and raising wages, examined after six years of experimentation, has failed, Dr. Wolman said,** and concluded: "The trouble is we not only have the original problem still with us; we have a new problem created by the machinery set up to solve the old problem and the fact that people are getting accustomed to this new level of public spending."

The machine tool industry continues to show progress, the volume of new orders in February advancing to the highest level since September, 1937. The index of the National Machine Tool Builders' Association touched a high of 167.1 last month, compared with 150.8 in January and 75.7 in February, 1938.

An interesting major industrial improvement of recent months in Greater Cleveland was the construction of the **new plant of the Linderme Tube Co.** on E. 219th Street, Euclid, Cleveland suburb. The plant now is in full production. The company purchased ten acres of land and improved it with a plant 500 by 125 feet, providing 62,000 square feet of floor space and an office building. Lighting is the latest, **with the upper twenty feet of the side walls of clear glass.**

The plant floor contains many thousands of feet of conduit and copper tubing for electric wiring and water, air and gas lines. In the new plant there is **efficient handling of materials.** Raw materials are brought in and finished products shipped by truck and by freight cars which are switched into the building on a depressed track. **Overhead cranes transport materials and products** direct to any part of the plant and to loading platforms. The building has one row of posts down the middle of its length with a 60-foot span of roof on each side. Greatly increased business made the new building imperative, according to Emil N. Linderme, president. The building and land cost $160,000 and new equipment an additional $50,000. Over a period of several months new equipment was installed and used equipment moved without interfering with company business. All machinery in the plant is powered by electricity. **In the opinion of Linderme the plant is one of the most modern tube mills in the country.** It manufactures seamless copper, brass and aluminum tubing.

Volume of **government orders** acquired **by** the **Reliance Electric & Engineering Co.,** Cleveland, for electrical equipment **has grown to the extent that the company has found it advisable to reserve a definite portion of its production facilities** for handling this kind of business, Clarence L. Collens, president, announced. The company manufactures motors and electrical equipment. "In addition to army and navy orders," **Collens said, "an increasingly wide variety of industries are showing an active interest in improving their manufacturing methods and processes.** This in turn has called for installation of the most modern motors and related electrical equipment to realize a satisfactory return upon investments in such rehabilitation work.

Sudden illness on March 18 claimed the life of Charles B. Coates, electrical engineer for the Chicago Pneumatic Tool Co. and inventor of high cycle electric drills and other electrical industrial equipment. A native of Erie, Pa., and graduate of Cornell University, Mr. Coates had been with the Chicago Pneumatic Tool Co. for 30 years.

Cleveland's **latest manufacturer of gas furnaces for the home, the fifth concern to enter that field there, is the Perfection Stove Co.,** with plants on Platt Avenue and Ivanhoe Road. **Perfection** has **just gone into production of a gas-burning winter air-conditioning furnace** which has the feature of continuous operation of the fan for the circulation of the air. Officers of the company believe **this is the first gas furnace in which the fan runs without stopping.** The idea originated with the company's oil burners.

Location of an aircraft manufacturing plant in Fort Worth, Texas, to employ 900 persons has been announced by A. P. Barrett of Fort Worth and J. B. Miller of Los Angeles. The factory will be established by the National Aircraft Corporation, recently incorporated in Arizona, and now holding a permit to operate in Texas. **The plant will have a capacity of four planes per week, of military type.** Production of the initial plane is expected to start immediately. **The plant,** in all probability, **will be built near the airport. It should be in operation by late summer.**

The **Armstrong Tire & Rubber Co. has opened a $300,000 factory in Natchez, Miss.** Construction of **the plant, warehouse and offices was financed by a $300,000 municipal bond issue,** and the whole was leased to the **Armstrong** company, which **agreed to install at least $500,000 worth of equipment and pay a nominal rental for five years.** Municipalities elsewhere have offered tax exemptions and other inducements to obtain industries, but Mississippi cities are the first to finance an enterprise outright.

Georgia's industrial plants now can insure themselves against depression losses. A bill, enacted into law by Gov. E. D. Rivers' signature would permit plants to form co-operative associations to insure themselves against losses resulting from shut downs during depressions or from lack of orders.

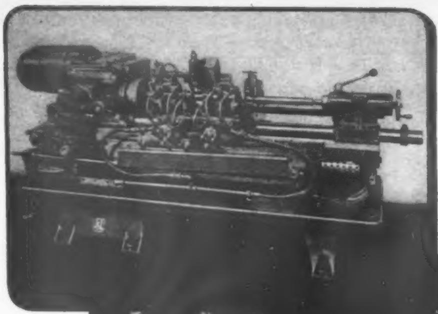
May & Lofland Corporation has opened a steel fabrication plant on Maple Avenue Road, in Dallas, Texas. Also in Dallas, the Cook Manufacturing Company is now producing oil well equipment and supplies at 402 South Beacon Street. Westinghouse has leased a three-story building at Camp and Griffin Streets in Dallas. The building is now being completely rebuilt to house the Southwestern headquarters of the company.

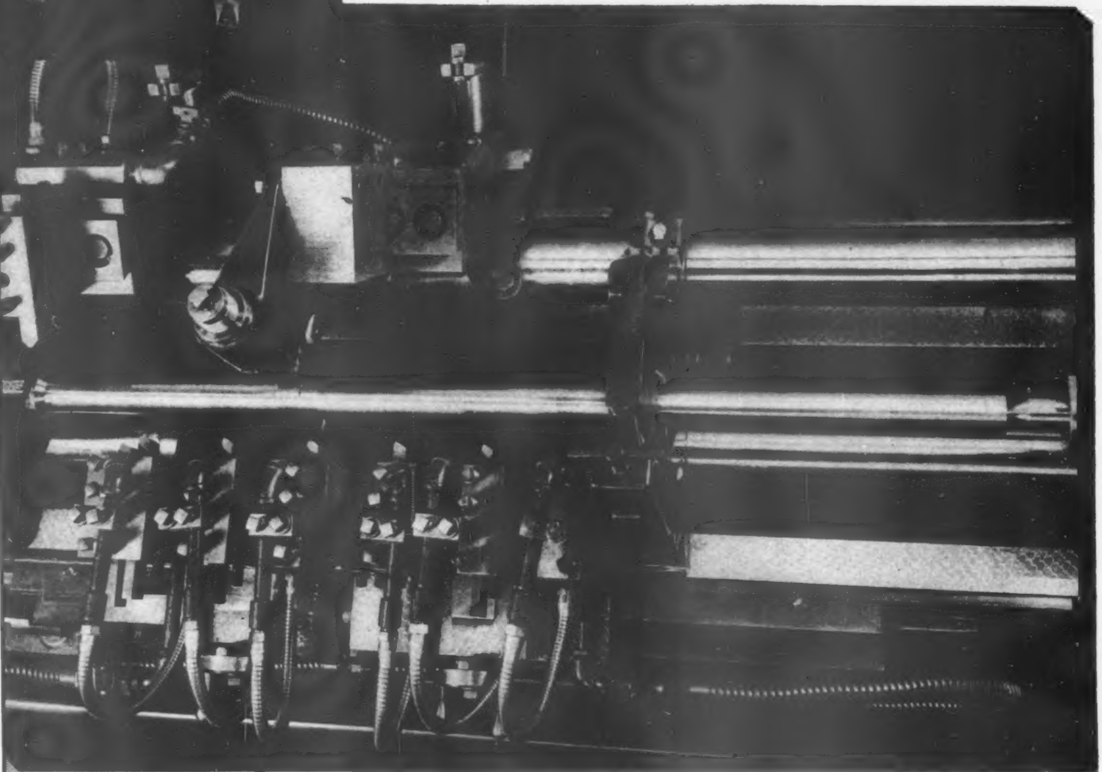
East

The **number of employes in manufacturing in Massachusetts in February was greater by 5.5 per cent** than the number in February 1938, a report of the Department of Labor and Industries reveals. Payrolls were up 11.4 per cent. Employment showed less contraction as compared with January than is usual for the period. The department's index number of industrial employment stood at 78 in February this year as compared with 69.2 in February, 1938.

Leo F. Hunderup, assistant general manager **of** the **Van Norman** Machine Tool Company, Springfield, was **made a vice president** of the concern at the annual meeting March 7 in the company offices. All other officers and directors were reelected. According to James Y. Scott, executive vice president and general manager, business in 1938 averaged about the same as in 1937. For the current year, Mr. Scott said, better prospects are in view. Orders at present

(Continued on page 60)





Handy Andy Says —

Hi-Lights of the Convention. At the Show, the eddying surge of the crowd, a human stream with its cross currents. Widening eyes and quickening steps as the magnitude of the exposition first impressed the incoming spectator, slowing feet and tired lines on exit. But, the impress of satisfaction at having seen an Epic of Progress. Each exhibit a fresh interest that drew the prospective buyer as the idly curious—and apparently, there were few of the latter. Said one exhibitor: "That's the fine part of this Show, that we get together with the actual users of equipment instead of contacting the purchasing agent first. Here we reverse a procedure that too often causes misunderstanding." And, from several score exhibitors, in answer to my question: "A grand success. It paid us."

▼ ▼ ▼

Me, I took it all in, concentrated on hydraulics, my specialty, the rest of "my gang" splitting up and getting the lowdown on individual preferences; drives, tool room equipment, rolling stock (yep, they had shop trucks too) welders and riveters. Future business, you know. Works Manager Almdale (Almy to his friends) ran us ragged, being indefatigable himself, but I had a good excuse (having had the flu—plus) so hied me for a rest at the A.S.T.E. horseshoe. Johnny Adams knew what was coming, anticipated with corn plasters; Cass Kaspar, new C.E. at Midland, took it smiling. Expect to make A.S.T.E.'ers of these boys after a bit; that's how I got Johnny Boe and other good members, inviting 'em in. A grand outfit, this A.S.T.E.

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Met Dr. Edgar DeWitt Jones during the Preview, in one of the aisles, and he stepped right up and greeted me. "How do you do, Mr. Rylander." (That's my name; okay, my anonymity has been punctured long ago.) And you know, I was so surprised that I just stopped myself from responding with, "Oh, Dr. DeWitt Clinton!" But just think! I had met the man once, and casually at that, several years ago at one of our dinners, when he was guest speaker—subject "Lincoln," by the way. He is a leading authority on the Great Emancipator. And he picked me out of the crowd despite that he has probably met thousands of people in the interim. It's a gift. As for myself, my weakness is reconciling names and faces; while I seldom if ever forget either I just can't seem to tie 'em together. Got Clyde Hause and Prof. Boston mixed up and had to feel my way. But then, they look somewhat alike—when you meet 'em apart. At that, I've developed a fine memory system when it works; if a man's name is Steel I think of something hard and likely as not call him Mr. Flint when next we meet.

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I sat, with the submerged three hundred at the Preview dinner, quite awed at the galaxy of bigwigs at the Speakers table, not but what we didn't have a few big shots in the "pit." A minister and a priest, each a spiritual leader and a force in the community, three educators, a head of a great Institute, several industrial leaders, on the dais, and, as aforesaid, the three hundred around me, all gathered together in what—paraphrasing from Zane Grey — may be called the wonderful freemasonry of this A.S.T.E. And the thought came to me, as it must have come to the rest, that this Society must have something to draw such a gathering. For here was no emotional appeal to the curious, but hard-headed men come to listen to what many consider the drabness of cold fact. Fact, you know, is seldom thrilling, unless dramatically presented at a sensational court trial. But Prof. Younger presented facts that were of vital interest to his audience, impressed them on our minds, and Dr. Moulton followed with a talk that was of deep significance in an age of transition. I am grateful for the privilege of having been there.

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I'm plumb tickled with the election of

(Continued on page 48)

HANDY ANDY SAYS

(Continued from page 46)

officers; just what the doctor ordered. We're growing apace, you know, and it's poor engineering to prop up a looming skyscraper with 2 x 4's; we need substantial timber, especially after the record set by Walt Wagner. And I think that Jim Weaver will build well on the foundation laid. Honest Frank Crone was the logical candidate for Treasurer, although I feel kind of sorry for the guy. You know how it is; a fellow can get so good in a particular line that he's held down because of it. Use him right, gentlemen, Frank's a grand ol' A. S. T. E.'er. And d'Arcambal! — friendly, likable and capable; he'll make a fine V.P. What particularly pleased me was the election of Ed Dickett of Rockford—and Sundstrand—and Floyd Eaton to 2nd V.P. and Nat'l Sec'y, respectively. Ed is a fine fellow who, in my opinion, is destined to go far, given an even break, and Floyd is the boy that I picked out of the crowd a few years back because he looked so eager to go to work. Thanks, Floyd, for not letting me down; you've exceeded expectations.

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Connie Hersam, irrepressible from Philly, organized a "Scotch Finding Committee," got quite a charter roll including Hizzoner Dick Reading, happy mayor of Detroit the Dynamic. Connie is well liked, oozes enthusiasm and takes occasional defeat like a gentleman. I always thought those Quakers were a dour lot, but between the Ch'mn from Philly and A.S.T.E.'er Cadwallader I've had to change my mind. (I still think the Dutchmen talked the Swedes out of Delaware.) The Royal Order of Hounds met at the Harmony Club Wed. nite, elected W.B. (Slim) McClellan Leader of the Pack, Gardner Young of Pittsburgh Ferocious Barker (it's a national order, you see) and Dick Thompson Guardian of the Bone Pit. Requirements for membership are as follows: Open to A.S.T.E.'ers; applicants must drag "Snoopy" thru the official convention hotel and contribute a token to the Hounds, also, must throw a bone into the bone pile. Among the charter members present were Yr's Truly, Arnold Hague and J. W. Hansen, besides the electees mentioned. We meet again at next call—and watch us grow. Yip, yip!

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I've dined and wined enough to hold me 'til next fall, when we meet in Paul Rossbach's home town, Cleveland. Mgr. Frawley of Hotel Ft. Shelby gave a fine blowout to the inner circle Wed. nite, and while it was frankly a matter of business policy the hospitality was so genuine that one quite forgot that phase of it. Going the whole way, Mr. Frawley included His Honor, Richard Reading among the guests, and what a royal good fellow he turned out to be. (And a darned fine mayor, too, if anybody should ask you.) A versatile chap, too, with a profound knowledge of tools. (I almost wrote profane, having once been introduced as a profane student of whatever I was supposed to talk about.) Coming back to tools, it's funny how we will talk shop despite the occasion. A round table symposium disclosed that, for proper hardening, small tools (material considered) should be quenched in oil, and are the better for an occasional annealing.

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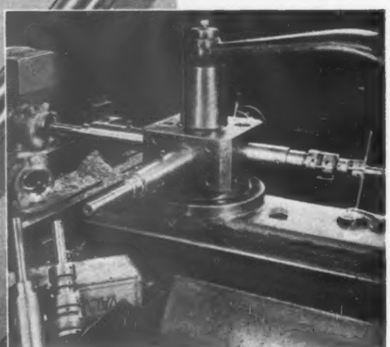
Met Lee Diamond in the crowd; he's back in harness as Detroit Sec'y. Funny how they pop up, these early birds of the A.S.T.E. Take Joe Siegel, now—what would we do without Joe for entertainment? Oh, he's the berries, that genial guy from Packard, knows everybody by their first name including the gal with the million dollar smile. Also met A.S.T.E.'er A. N. Goddard (of Goddard & Goddard), a pleasure long deferred. He's on my books as the Philosopher of the A.S.T.E. And Paul Zerkle of Cleveland—the fella looks younger every time we meet. Saw Doogan's old man through the smoke at the Dir. meeting, and had chance for a bare nod and a handshake with the boys N-E-W-S in the rush of events. They're coming in pretty fast now, and hard to keep track of. Well, you know me,

(Continued on page 50)



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HANDY ANDY SAYS

(Continued from page 48)

boys, so don't be bashful about saying hello, especially after seeing my picture so often these past few weeks. Denny Fargher took it, although I really look handsomer in real life. At least, so my youngest tells me.

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Geo. Keller introduced me to a Dane from—Buffalo, was it?—by name of . . . ?(Demme if I didn't mislay his card!) Wait now . . . Ah, I have it! Thorvald Bruun, it is. Get my system? I thought of a color and there you are. Or was it a bear? Well, no matter. Anyway, I talked Swedish and he talked Danish and we got along fine—mostly in English. George K. succeeds me as Ch'man of Editorial Committee, which gives me a chance to get my new house built before snow flies again. Best of luck, George—and don't let 'em get you down. Otto Winter commuted from Tonawanda, and I met a man from Nicholson File who promised to send my regards to old pal Art Peterson who is a foreman or something in Providence. Drop me a line, Pete, if you get the message—or see this. You know, these A.S.T.E. conventions remind me of Old Home Week—you just meet oodles and oodles of old friends, let alone the new friendships you make. Personally, I have formed many fine friendships since joining this A.S.T.E., friendships that will endure thru life and will doubtless leave warm and lasting memories long after the final exit. Skoal, friends! May we become inextricably entwined in each others' regard.

▼ ▼ ▼

Did you ever stop to consider the innate friendliness of big men? And how versatile they are? Take Bill Stout, for instance, who gave us such an interesting and inspiring talk at the Big Dinner Thurs. nite. His versatility is proven by his many interests; he is, in addition, a rapid sketch artist, can whistle the way I always wanted to but never could and, from what I could gather, is rather musical. (Excuse it if I'm wrong, Bill—I know you're only human after all.) What got me plumb flabbergasted was the way he started his talk; it was something new in Scandinavian dialect and it took me a while to get tuned in. In fact, I asked my next-elbow neighbor what nationality the guy was. Anyway, it turned out to be another one of those stories in which the Norwegians get the best of the Swedes, and that always brings the house down. You know, like "What's dumber than a dumb Norwegian?" and you say "A smart Swede." Oh yeah? But a Swede by name of Edgar Bergen took a "son-of-a-beech" (L. Clayton Hill, Murray Corp., author, not me), called him Charley McCarthy and made the celebrities of stage, radio and press stooges for a wooden dummy. By the way, wonder why they pin Irish monikers on so many Swedish actors down in Hollywood? It's as screwy as calling Notre Dame football players fighting Irishmen. In passing, that choleric head waiter at the banquet had me fooled, too—almost up to the time Joe Siegel threw him out. Good work, Joe, I think you saved the guy's life.

▼ ▼ ▼

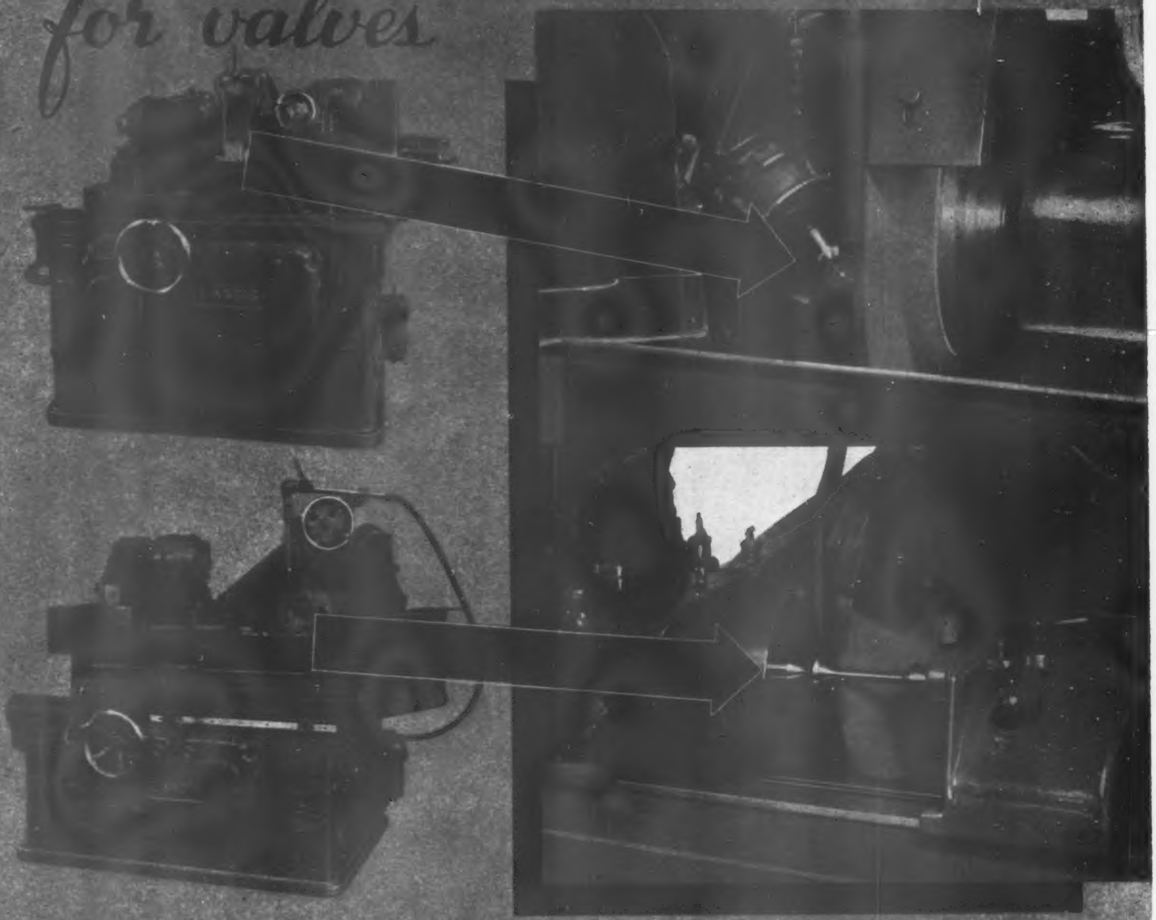
Homer Bayliss and Frank Shuler co-starred as Show and Programs Ch'men: congrats from the top clear down the line, including Ford Lamb. Ford, you know, does most of the work and passes the glory along. Carl Oxford, sturdy Norseman, Ch'manned well at the Symposium, all of which makes interesting and instructive reading. And while I haven't run out of material about the Show, I'll have to save a thought or two for next issue. The echoes, you know, will reverberate for some time to come. For your info, Bert Carpenter is in France and—oh, "Rinky dinkey parlez vouz!" And Bob Lippard, convening from Worcester, was preparing to fly down to Texas just after the big dinner. Happy Landings, Bob! Meant to send greetings to A.S.T.E.'ers Gallant of Chi and Clark(son) of Twin Cities by Clif Ives and Geo. Wise, but missed out in the excitement. Heard from Pete Dubois that Guy Swartz and LaMonte are sunning themselves in Fla., a good place to be (and I wish I was there too but not now with spring coming on). Had a nice long letter from Bill Williams, all about guns and things and some homely philosophy on the side. Quite a guy.

▼ ▼ ▼

"The best laid plans of mice and men

(Continued on page 52)

2 NEW GRINDERS *for valves*



There have been numerous new developments lately in Landis valve grinding equipment. Two of these are illustrated.

The upper is a 6" Type C Hydraulic Valve Face Grinder, a machine designed primarily for the rapid semi-automatic production grinding of automotive valve faces. The second machine is a Landis 10" Type C with the wheel base set at an angle and tooled to grind the radius under the head of an airplane valve.

Catalog No. G-38, just issued, tells about these machines in detail and explains many of the other valve grinding operations which modern Landis equipment is being used for today. May we send you a copy?

292

LANDIS

LANDIS TOOL CO. WAYNESBORO, PA.

GEAR TOOTH FINISHING

(Continued from page 35)

erally in the direction of gear operation. The most effective range of gear shaving lies between 3° and 30°. Beyond 30° the cutting action increases in severity but the guiding action greatly decreases, therefore, it is best, if possible, to shave gears with crossed axes between 10° and 15°, although much successful work is done at 5°.

Another interesting feature is cutting of gears adjacent to others, called "shoulder" gears. In this type of work the center of crossed axes is not in the middle of the cutter but close to the side of the cutter adjacent to the shoulder.

This permits the cutting of many gears which are within ¼" of an adjacent shoulder.

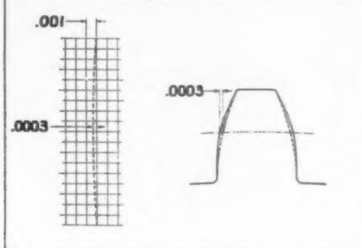
An interesting feature is the type of chip which is a long twisted chip of hairlike portions, .003 to .004 thick.

In finishing gears by shaving a rounded bottom between the teeth tends to cause excessive cutting at or below the base circle which affects the profile of the adjacent teeth. Rough cutting the gears with a lesser pressure angle helps to avoid this and is more desirable than the use of protuberance cutting teeth.

The cutting tools for this type of work are made to cumulative error of .00025 and this can readily be reproduced in the production when care is taken in the maintenance of equipment and inspection.

It has been the custom to make modifications on gears, particularly at the top of the tooth. These modifications have been carried deeper and deeper on the tooth until the top of the tooth is of no use, as it does not come in contact. These heavy modifications are totally unnecessary.

CORRECT MODIFICATION OF TOOTH FORM



The small modification necessary for quiet gears is illustrated in fabric timing gears where .0003 modification at the pitch line with a total fall off of .001 was successful.

The difference in chordal thickness to give proper crowning on automobile gears is approximately one thousandth. Thus the face of the gear will have not over a half thousandths fall off from the center.

Crowned gears combined with the former modification in the involute has a tendency to give a spot bearing in the middle of the teeth which is not as desirable in spur and helical transmission gears as it is in bevel gears.

It is our experience that crowned gears will find a larger and larger usefulness as they are a great relief to misalignment of bearing and deflection of parts.

HANDY ANDY SAYS

(Continued from page 50)

oft gang aglee," and, having plenty of chance to, it is inevitable that we pull a boner once in a while. One howler (I saw it when I read the printed matter in the "Tool Engineer"—and where was the checker?) concerned B. C. Ames Co. of Waltham, and I hoped against hope that it would pass unchallenged. But no!—the "Tool Engineer" is read, and apparently your columnist is not unnoticed because I've had plenty of ribbing about my twist of the king's English. I wrote (regarding Ames indicators) that "I had one in my hands just a few days ago, no more reliable . . . but just as sensitive . . . as its predecessors of some decades ago." I should have said, naturally, "just as reliable." But what the heck! If a thing is right it's right, and you can't improve much on a product that was right from the beginning. But excuse it please; I'll be more careful from now on.

GAGES

(Continued from page 36)

ments in gages is because of "humanistic" and "humanitarian" considerations. When product accuracy is specified in "tenths" gages must talk in "hundredths." With the tendency toward closer limits this means that many production gages must be capable of revealing quantities that were considered laboratory problems only a short time ago. There are many production jobs today that run in one and two hundredths. Therefore, as touched upon previously, greater understanding, skill, and technique must be built into the gage; the importance and influence of the operator must be minimized. In other words, the significance of that elusive quality commonly referred to as the "human element" is being reduced as much as it is possible and practical. Another reason why the humanistic factor is an influence on gage development is because of the prevalence of willful, though not always detectable, indifference on the part of operators in the use of gages, and, on the other hand, because of demands for results both in precision and speed of gaging that tax the skill and endurance of experienced and conscientious operators. Between these conditions which have been largely imposed by increased competition and from which few if any manufacturers are immune, it is obvious that an effective defense and attack measure is in the development and use of gages that relieve the operator, as far as possible, from the need to think and exercise more than ordinary caution, but which, on the other hand will correctly permit management to place an even greater responsibility for results on the operator.

From the humanitarian viewpoint there has been noteworthy development primarily in that type of gage which has reduced or entirely eliminated difficult and hazardous gaging of parts or materials. Continuous gaging of strip material in motion in the rolling mill industry is an outstanding example. Another humanitarian influence on gage development is in the checking of certain vital parts, as, for example, in explosives, time fuses, etc., where life itself is jeopardized by incorrect and inattentive gaging which may be caused by wholly unavoidable human failure caused by mental and physical fatigue which is primarily induced by high production schedules and rhythm and automaticity of the gaging operation. In the case of this type of work gage design and operation must guard against error and failure of product and operator alike.

Summarily, then, there are four main reasons for the recognized progress that has been made in gage development—in brief they are Technical, Economic, Changed Viewpoint toward the function of gages, and Humanistic and Humanitarian influences.

Let us now consider what these influences have yielded in the way of improvement and new developments in Gages.

Simplification and Standardization

In the first place there has been a far reaching simplification and standardization program in the design of standard gages like thread plug and ring, cylindrical plug and ring, plain limit snaps, etc. This has been brought about largely by remarkable cooperation between gage manufacturers themselves, and further, through combined efforts of gage manufacturer and gage user, i.e., Industry itself. And there has been standardization within certain industries as, for instance, the railroads, the oil industry, and others—with the result that there is almost complete standardization of gages peculiar to these and other special fields.

There has been a standardization of certain types of conventional gages; for instance, cylindrical plug gages are now made in various grades of size accuracy, and in various grades of "finish." Obviously, the coarser grade in size and finish is less expensive—thus the gage user now has an opportunity of selecting the class of gage which meets technical requirements and at the same time gives greatest gaging economy.

There has been marked progress in

(Continued on page 56)

GAGES

(Continued from page 54)

increasing the durability of gages—and this has been brought about by the use of wear resisting materials. Special alloy steels, chrome plating, the carbides—tantalum, tungsten, boron, etc., and even diamond is now generously used, especially for the contact points in comparator type gages.

Real advancement has been made in internal and external indicating type gages—both in the construction of the gage frame or body, and in the indicating elements. Ruggedness and durability, increased accuracy and greater amplification, characterize the general improvements of this type of gage.

Outstanding Developments

There have been outstanding developments in the application of the basic elements—air, light, and electricity, as the means of indication in so-called "reading" type comparators. Much progress has also been made in the construction and accuracy of mechanical dial gages. Considerable progress has also been made in the design and use of compound gages, i.e., gages that check several independent or correlated dimensions of a part simultaneously. And for irregular shaped parts—optical projectors have reached a degree of perfection that causes all Industry to be its debtor.

There is sufficient indication to justify the belief that we are on the verge of an interesting and extensive automatic gaging era. This will require an extreme degree of cooperation and a "meeting of minds" on technical and economic issues on the part of both gage user and gage manufacturer.

To attempt to go into specific detail at this time regarding latest developments made in gages would be entirely out of place. The displays and the intellectual horsepower of the various exhibitors at this Exposition serve this end far better than general harangue. Therefore, to borrow from the Automotive Industry may I suggest that you avail yourselves of this opportunity to "look at all three"—but, in the case of the gage industry I should probably say "all eight or ten." While the gages displayed here are primarily "standard" types, I am sure that they are suggestive of what can be done in the direction of specials—compounds—etc., to meet individual requirements and unusual problems.

Let me acknowledge and emphasize the fact that a cooperative and constructively critical Industry, i.e., the gage user, has contributed immeasurably to the progress that has been made toward better gages and gaging methods. The progressive gage manufacturer has entirely abandoned the idea that he is qualified independently to develop practical gages for any Industry. It has resolved itself into a purely cooperative endeavor—and progress in gage development will continue to an extent and rate that is directly proportional with the degree of cooperation between gage user and gage manufacturer.

In the interest of progress, therefore, the continued cooperation of the gage user is earnestly solicited. And may I emphasize that the assistance of the low production—miscellaneous manufacturing industry—is especially needed, for the solution to his problems are usually more difficult and involved than those presented by high and continuous production.

Effect on the Tool Engineer

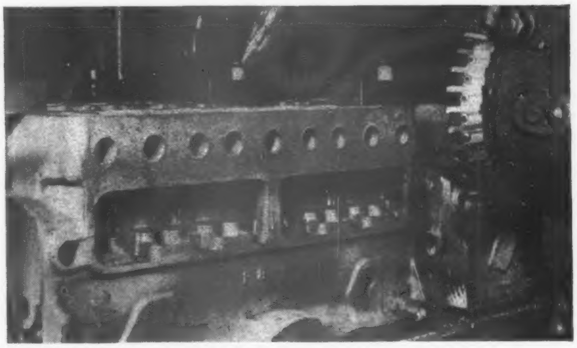
We are now on the home stretch of this problem: "What is the effect of all this gage activity and gage development on the Tool Engineer?"

From one point of view the Tool Engineer has almost reached the promised land—because there is available today an efficient gage and gaging method for almost any and every gaging problem. Available gages will give the answer to the question of dimensional accuracy in almost any manner desired—a brief yes and no as from Go and Not Go cylindrical plug gages, a reading on a mechanical dial indicator or an electrical meter, a photoelectric recorder, a cathode ray oscillograph, or it may be set to flashing lights—yes, even sound. The answer may be given by a streamlined mechanism whose only indication of action is the rapidly diminishing quantity of

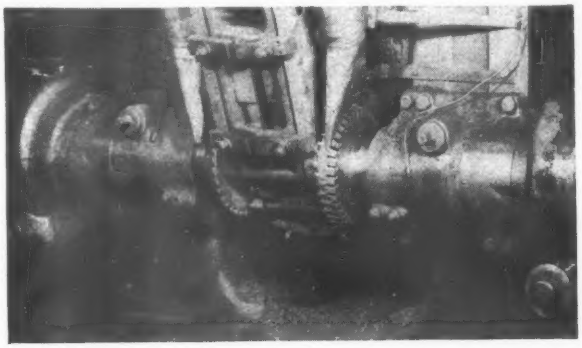
(Continued on page 58)

Haynes Stellite J-Metal Blades are <u>Standard</u> on these Milling Jobs because *they reduce the cost per piece machined* . . . .

Rough- and finish-milling the contact faces of clutch housings with Haynes Stellite J-Metal milling cutter blades at 134 surface ft. per min. with a feed of 10 in. per min.



Rough- and finish-milling the cover side of cylinder blocks with Haynes Stellite J-Metal blades at 81 and 92 surface ft. per min. with a feed of 22.4 in. per min.



Rough- and finish-milling the top surface of cylinder heads with Haynes Stellite J-Metal blades at 147 and 184 surface ft. per min. with a feed of 17.4 in. per min.

Haynes Stellite engineers are widely experienced in production work. They will gladly help you select the most economical cutting tool for each operation. Phone or write for this service today.

PRODUCTS OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

"Haynes Stellite" is a registered trade-mark of Haynes Stellite Company

J-METAL HAYNES STELLITE TRADE MARK

Red-hard, wear-resisting alloy of cobalt, chromium and tungsten

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

Chicago - Cleveland - Detroit - Houston - Los Angeles - New York - San Francisco - Tulsa

General Office and Works—Kokomo, Indiana
Foreign Sales Department—New York City

Haynes Stellite hard-facing rods and information on other Haynes Stellite Company products also are available through all apparatus shipping points of The Linde Air Products Company

GAGES

(Continued from page 56)

parts in the hopper and the purr of solenoids in perfect rhythm.

But on the other hand this fact does not necessarily simplify the Tool Engineer's problem, for in the first place he must be more than reasonably familiar with all available gages and gaging methods and he must stay abreast of new developments. Secondly, he must judiciously develop a controllable and workable advisory board of qualified consultants, with whom he can discuss his gaging problems in confidence.

With the greater variety of gages available, and with the various and sometimes conflicting viewpoints and recommendations of an advisory board comprised largely of gage venders, it means that the Tool Engineer himself—to purchase to the best advantage—must have keen insight into all details and be able to compare the relative merits of various types of gage and gaging method. In addition to requiring the ability to determine which is the "best buy," he must have the intestinal fortitude to execute his convictions because frequently it means with these new developments in gages that the "best buy" involves a greater or lesser change possibly in machining as well as gaging—an upset of traditional ways of doing things. This certainly suggests that the Tool Engineer's authority as well as his courage should be sufficient to provide for such a contingency.

The Best Buy?

A further need for intestinal fortitude may arise from the fact that the "best buy" may involve an original expenditure not covered by the estimated or appropriated fund—this requires the courage to go "up front" for adjustments in appropriations. At this point let me emphasize that it is the "cost of gaging" not the "cost of gages" that should be the determining factor in gage selection. If the real interests of his organization are to be served the Tool Engineer cannot purchase gages by the pound or by the dozen—and short sighted penny-wise but pound foolish methods of selecting gaging equipment must be discarded in this era of tremendous gage development and keen competition.

In order that the Tool Engineer may be in a position to correctly "gage up" a job he should know the production schedule, the accuracy to which the work is to be held, the manufacturing methods, and he should have a basic understanding of the functional requirements of the product—service and replacement conditions, etc. That is, to take full advantage of available gages and the best gaging methods his knowledge and attitude must reflect a broad perspective and not a restricted and departmental viewpoint.

Furthermore, to correctly determine the type of gage to purchase for a gaging operation — the Tool Engineer should know, if it is a job that has been running—exactly how much it is costing at present to gage that job. This "cost to gage," let me point out, is the sum of the cost of the gages plus the cost of maintaining and replacing them, plus the cost of using them; with this figure should be merged the results of gaging from a quality standpoint. It is only by being intimately familiar with present and past gaging performance and cost that the Tool Engineer is in a position to make proper selection of either replacement or new types of gage.

A certain automotive concern has long advertised that its line of cars is sufficiently complete to fit "every purse and purpose." Most of us, as occasional car purchasers, realize how overlapping the various price classes of cars are, even those of a single organization. The gage situation is very similar—there is a gage for practically every purse and purpose. Therefore, if he is to get sound practical advice from his gage advisers, if he is to get the "best buy" for his requirements, the Tool Engineer must know exactly in infinite detail just what his gaging problem is. Is it length, diameter, roundness, straightness, squareness, alignment; is it grading for selective assembly—just what is the problem? What is the scheduled production? Is a yes and no limit type "feel" gage

(Continued on page 66)

Two things to do about new Equipment

Has the recent Detroit Convention given you a yen for one of these new wonder-working machine tools to speed the progress of your work?

IF THE MONEY IS THERE TO BUY IT—go ahead, by all means.

The power, speed, and simplicity of its operation will open a new path to faster production and lower costs. But no matter how modern—how powerful—or how fast the new machine may be—before it can bite into a single job, it must be equipped with teeth. And these teeth are the tools—proper tools that can match the new ability of the machine to perform.

To help you develop maximum efficiency in your modern equipment, the Carpenter Steel Company has worked out a system of Matched Tool Steels. It simplifies tool steel selection and helps you extract every ounce of production from your new machine tools. The Carpenter Wall Chart Tool Steel Selector shows how this system operates. Mail the coupon now for your copy and lay it before your tool room.

OR IF THE MONEY ISN'T AVAILABLE—you can still get improved results without investing a cent.

Your present machine tools can be made to yield increased production—faster speeds—smoother finishes. It is being done in hundreds of plants throughout industry with the aid of the Carpenter Matched Tool Steel Method.

Here is a successful, proven plan for getting *more* out of your present equipment. Years of research and practical tool room use have gone into its development.

To help you apply it to speed your own jobs into production—and to protect your important recommendations, we have prepared the Carpenter Wall Chart Tool Steel Selector. The coupon below will bring you this guide that safely shortens the time between planning and production. Send for it now.

THE CARPENTER STEEL COMPANY, READING, PA.

MAKERS OF FINE TOOLS SINCE 1889

FREE WALL CHART AND MANUAL

THE CARPENTER STEEL COMPANY
122 W. BERN ST., READING, PA.

YES, I am seeking new ways to speed jobs and reduce costs. Without obligation, send me a Free copy of your Wall Chart and the 50-page Tool Steel Manual that shows how to put your system to work.

Name .... Title ....

Firm ....
Firm Name Must Be Given

Address ....

City .... State ....

PRODUCTION PERSPECTIVES

(Continued from page 44)

are slightly above last year and a continued increase is anticipated.

The **Baush Machine Tool Co.** of Springfield **has received two War Department contracts** totaling $12,597. One contract, for a barrel-reaming machine, totals $7,850, and the other for a three-spindle reaming machine, $4,747.

Marshall B. Waterman, 72, a **director of** the **L. S. Starrett Tool Co., Athol,** and for **many years** a member of the firm and **assistant superintendent died March 10 in Haines City, Fla.**

The **Indian Motorcycle Company** and its subsidiary, the Indian Acceptance Company, Springfield, sustained a net loss of $11,776.09 for 1938, but the company, **according to Leslie B. Mason,** secretary and treasurer, **is continuing to operate on a sound basis.** The financial statement, he declared, shows a very favorable ratio of assets over liabilities and the company is in a better position to go ahead than it has been for many years.

The **Millers Falls Company,** Greenfield, **added a bright note to the industrial picture when, following the annual stockholders' and directors' meeting, it was announced that the company had been able to pay full dividends during 1938.** "We made a sufficient profit," said President Philip W. Rogers, "to pay a full dividend on both the first and second prior preference stock and a normal dividend on the common, as well as carrying a modest amount of surplus."

The **Billings & Spencer Company,** Hartford, Conn., **has completed negotiations for the purchase of the wrench line of tools of the Bemis & Call Company of** Springfield. Included in the purchase is the Coes wrench products. Purchase includes machinery, tools in process of production, and inventory. **Billings & Spencer Company is moving plant equipment and materials from Springfield and will go into production in Hartford.** The Bemis & Call distribution outlets are already well established and business can proceed normally. Bemis & Call acquired the business of the Sesamee Lock Company of Hartford several months ago and those production operations were then moved to the Springfield plant.

John Oliphant McKean, 67, internationally known in the machinery industry, **died February 27** in Wesson Memorial Hospital, Springfield. Mr. McKean was president of the Foster Machine Company, Westfield, with which he had been identified since 1899; was a vice president of the Westfield Savings Bank and a member of its board of investment, a director of the Hampden National Bank & Trust Company and a member and former chairman of the Westfield Board of Public Works since 1921.

A **third shift has been added at** the East Springfield plant of the **Westinghouse** Company **as reemployment continues at the factory.** A few employes are being taken on each day, it was reported. The **total working force in the factory now is just short of 3,000.**

A spurt in business at the United American Bosch Company, Springfield, **has lifted the total number of employes to a new high** for recent years. More than 150 workers have been added to the payrolls since the first of the year. The **total now** employed by the company is approximately **950.**

Greenfield Tap & Die Corporation, Greenfield, **reports incoming business for the first two months of 1939 as more than 20 per cent ahead of a year ago.**

Henry S. Beal, who has been president of Sullivan Machinery Co., Chicago, **has been made general manager of Heald Machine Co.,** Worcester. Mr. Beal was formerly manager for Jones & Lamson Machine Co., Springfield, Vt., and served as president of the National Machine Tool Builders Association in 1932-33.

The **George F. Wright Steel & Wire Co.,** Worcester, **has increased its operations from four to five days a week,** according to George F. Wright, president. Orders on hand, although not of unusual volume, have permitted the increase in working schedule.

Charles Alfred Heald, 75, for many years a machine designer, died March 3, in Shrewsbury. He was employed as

(Continued on page 66)

Did You Visit This Exhibit?

WETMORE

OUR display at the Detroit Machine and Tool Progress Exhibition featured Wetmore Boring Bars, Units and Reamers.

Visitors were amazed at some of the applications we presented.

If you were unable to attend this Exhibition—it would be worth while to get full information on Wetmore tools—call your Wetmore representative or write—

Sales Representatives

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Wetmore Reamer Co.
4829 Woodward Avenue

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John W. Horne
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J. W. Mull, Jr.
333 North Pennsylvania Ave.

TOLEDO, OHIO
J. W. Mull, Jr.
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CLEVELAND, OHIO
J. W. Mull, Jr.
6007 Euclid Avenue

NEWARK, NEW JERSEY
W. T. Hutchinson
93 Bleeker Street

MALDEN, MASSACHUSETTS
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BUFFALO, NEW YORK
R. C. Neal Co., Inc.
76 Pearl Street

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R. C. Neal Co., Inc.
46 Andrews Street

SYRACUSE, NEW YORK
R. C. Neal Co., Inc.
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MINNEAPOLIS, MINNESOTA
Northern Machinery & Supply Co.
818 Lumber Exchange Building

PHILADELPHIA, PA.
Charles R. Yerger
7800 Bayard Road

PITTSBURGH, PENNSYLVANIA
J. T. Winterling
N.S. Station, Box 502

RACINE, WISCONSIN
H. S. Springhorn
1615 St. Clair Street

FLINT, MICHIGAN
C. P. Geyer
920 Walnut Street

TORONTO, ONTARIO, CANADA
H. H. Roberts' Machy. & Sup.
639 Queen Street, East

WETMORE REAMER COMPANY

Dept. TL 420 N. 27th St. **MILWAUKEE, WIS.**

CUTTING TOOLS

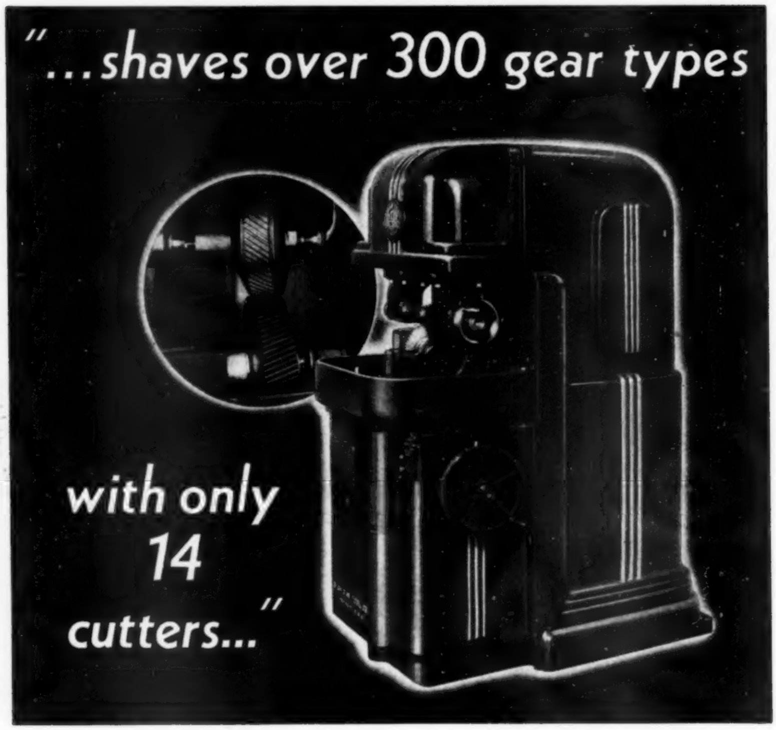
(Continued from page 37)

cents per pound base price is paid with the assurance that increased tool life will repay the higher cost of the material.

The other two Tungsten High Speed Steels are alloys of 14% Tungsten, 4% Chromium, and 2% Vanadium; one with no Cobalt and the other with a 5% Cobalt addition. Their use is limited to heavy turning operations on such limited applications as munitions work but they show the wide range of development of the Tungsten High Speeds for particular purposes, and the need for an understanding of these developments if tool engineers are to properly secify the material from which their designs of cutting tools are to be made.

The eight variations of the Tungsten High Speed Steels just reviewed cover a sufficiently wide range of characteristics so that we may choose at least one type for any job that can be satisfactorily machined with a forged High Speed Steel and expect complete satisfaction. It is not mechanical limitations of these alloys that has brought in competition by the Molybdenum steels but rather the economic limitations.

(Continued on page 64)



CHAPTER DOINGS

(Continued from page 42)

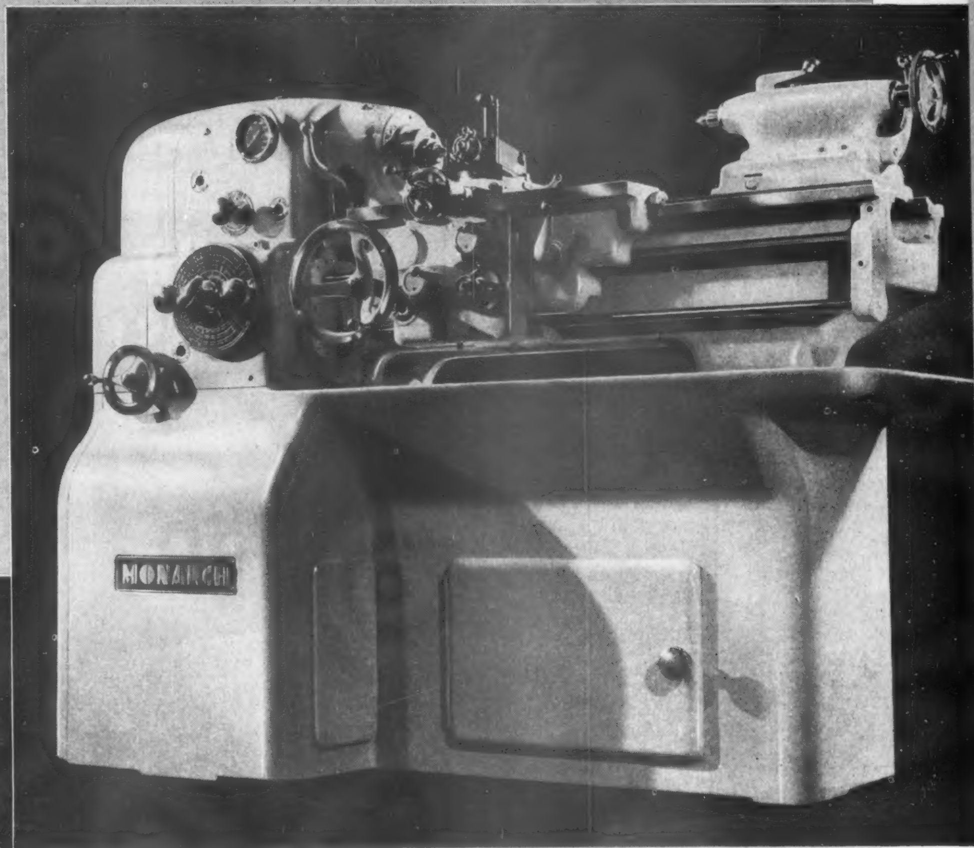
give him plenty to do. The trip to Detroit was discussed and plans were certainly well laid because there was a carload made the journey in a group. U.S. Steel Corp. presented an interesting movie on steel making from mine to finished product.

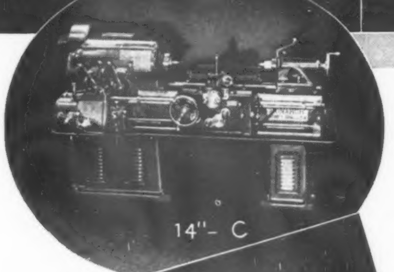
Over 300 members and guests turned out for the March 7th meeting of **New York-New Jersey** Chapter. Frank Sheeley, retiring Chairman, ushered into office Herb Hall, Chairman; Bill Brown, Vice Chairman. The re-elected Secretary and Treasurer were also sworn in. Remo Rege, watch dog of the treasury was much relieved to hear Auditor O'Brien report his books in good condition with a final credit balance of $154.00. Of this amount $144.00 was the profit Tom Orchard turned in from last month's party. Glad to see your name in print again, Bill Brown. Missed you at the show although I did see Eddie Prange. The speakers club is well under way. If you don't believe it just listen in after the meetings. A. J. Snyder of Morse Twist Drill and Tool Co. gave an interesting talk on the proper selection of tools. The feature of the talk was the use of the Delineascope, an optical projector that throws images of the objects themselves on the screen. He also illustrated the original patent on a twist drill granted Stephen A. Morse in 1863.

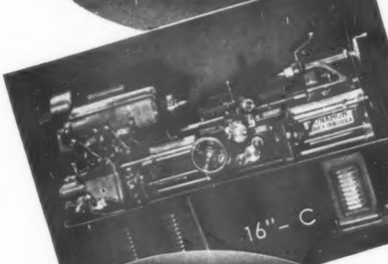
150 attended the dinner and floor show March 9th given by the **Rockford** Chapter. Nearly 400 were present for the lecture given by Mr. A. W. Green of the Alleghany Ludlum Steel Co. This lecture covered nearly every angle in the making of and use of Stainless Steel. Co-Chairman Henry Ruehl, Beloit, Wis., conducted the meeting which was one of the most successful held so far.

Seventy couples had a grand time at the second annual supper dance of the **Buffalo** Chapter. The highlights of the evening were a "speech" by Ot Winter and the Lambeth Walking by Ray Neal. Executive meetings were held on February 22nd and March 8th. These meetings were attended by the new officers and the various committee chairmen. Plans for the coming year were made and all arrangements for the trip to Detroit were completed. A membership meeting was set for March 27th. This meeting will be for members and each member is to bring a prospective member as his guest. Seventy members and guests made the trek to Detroit on March 15th. Had two special cars and everything went along fine. There was one member of this chapter who is sort of "high hat." Flew to and from Detroit. Just wouldn't ride in a common day coach with the boys. On the way back, we met up with an "Old Iron Monger."

THE NEW 10" *Sensitive Precision Lathe* ROUNDS OUT THE MONARCH TOOL-ROOM LATHE LINE







18"—C

THIS new and most complete streamlined 2. H. P. lathe effectively handles much of the work now being done on 12", 14", and 16" geared-head tool-room lathes. Besides producing such jobs in less time and with greater accuracy, the scientifically arranged controls of this 2000-pound precision machine make a "desk high" working position possible and definitely minimizes operator fatigue.

These illustrations only suggest the extent of the comprehensive line of Monarch tool room lathes. We will welcome an opportunity to make a comparative and competitive presentation.

Monarch Lathes Cover the Turning Field and Include:

- Engine Lathes
- AUTOMATIC SIZING
- Monarch Keller
- Magna-Matic Lathe
- 5-T Manufacturing Lathe
- 10" Sensitive Precision Lathe
- Model "C" Tool Room Lathes

Write for Catalog

THE MONARCH MACHINE TOOL CO., Sidney, Ohio, U.S.A.

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COVER THE TURNING FIELD

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Agencies in principal industrial centers of this and foreign countries.

MAKE *MORE GOODS FOR MORE PEOPLE* AT FAR LESS COST!

CUTTING TOOLS

(Continued from page 62)

Tungsten ore is not produced in the United States or its possessions in sufficient quantities to stabilize its price. As long as we are dependent on the world market for our Tungsten needs, we are at the mercy of foreign disorders and market operations over which we have no control. High Speed Steels are still an essential part of our national economic scheme and we cannot afford to be held up for the vital raw materials from which we can fabricate our cutting tools.

This uncertain supply and price situation of Tungsten and the desire to use our own natural resources to the best advantage have led to the development and marketing of the Molybdenum High Speed Steels. Molybdenum has approximately twice the alloying effect of Tungsten in imparting High Speed characteristics to tool steels. In some analyses it is used in combination with Tungsten, in others it entirely replaces Tungsten. A great deal of research is being carried on at present to develop new Molybdenum High Speed Steels and to further reduce the heat treatment problems that have given trouble to some users in the past. The tendency to decarburize at hardening temperatures can be overcome by the use of controlled atmosphere furnaces or salt baths. Several of the more recent developments are practically non-decarburizing and may be successfully heat treated without any special equipment. The characteristic dark red Tungsten spark is not as distinct in grinding the Molybdenum High Speeds as in the Tungsten types and this led to many complaints from early customers that tool makers were furnishing carbon tool steel tools rather than High Speed tools as ordered. Experience soon brought out the fact that although Molybdenum High Speed Steels do not have the same grinding spark as Tungsten, they do have at least comparable performance. As we have more opportunity to perfect our handling of the present analyses and develop new ones, we will build up experience that will prove very helpful in solving such problems as do arise.

The most widely used Molybdenum High Speed Steel is the Mo-Max type. Mo-Max is a proprietary trade name owned and controlled by the Cleveland Twist Drill Company and its only licensed use by others is on steel made and sold by licenses under the Cleveland owned patent. Mo-Max contains 8% Molybdenum, 1½% Tungsten, 4% Chromium, and 1% Vanadium. It is a general purpose material with performance characteristics comparable with those of the 18-4-1 and 18-4-2 Tungsten steels.

There are six other Molybdenum High Speed Steels now on the market. Their analyses differ from that of Mo-Max in the Tungsten-Molybdenum ratios, the addition of Cobalt, or the variation in percentages of the minor alloys, Chromium and Vanadium. These steels have all demonstrated remarkable cutting abilities on the limited applications on which there has been time to make test runs. It is not wise to closely predict future developments in a field that is changing as rapidly as the field of Molybdenum High Speed Steels, but we have every reason to believe that we will soon have enough actual production experience with the various molybdenum analyses to cull out those that do not fulfill expectations and concentrate on a few types that are capable of solving any problem to which a forged High Speed Steel is the answer. There is great economic comfort in having a suitable substitute for the Tungsten in High Speed Steel in the Domestic availability of Molybdenum. We can then rest assured that fluctuations in price caused by world market operations or inability to import Tungsten because of foreign disorders will not radically influence our High Speed Steels.

The ultimate possibilities of the forged High Speed Steels of various analyses have never been attained, nor will they ever be attained until proper production records can be set up by a careful study by tool engineers. There is plenty of information available as to

(Continued on page 68)

GAGES

(Continued from page 58)

sufficient—or should it be some kind of an indicating "reading" comparator? What degree of accuracy is required? If the gage is to be used on work in the machine what are the conditions—available space, etc., under which it has to be used? The Tool Engineer must know the answers to these questions and then he must post them conspicuously as a common target at which all the invited gage vendors may hurl their recommendations. It is only in this way that real constructive competition can be obtained—it is only in this way that the Tool Engineer can obtain the "best buy."

Enough has probably been said to convince the Tool Engineer that there have been tremendous advancements in gages and in the science of gaging which are available to him to promote the competitive position of his company, i.e., facilitate production, lower the cost of manufacture by increasing machine output and operator efficiency, prevent spoilage, and control the human element and humanistic uncertainties. It is obvious, I believe, that to fully utilize these advancements, of added coordination within his own organization, and also with gage suppliers is absolutely necessary if the Tool Engineer is to utilize gage progress to a significant degree.

In conclusion, then, the developments in gages definitely mean that the Tool Engineer is faced with the task of observing more completely, and carefully and courageously meeting the finer points of the game which have been mentioned in this article. Gage developments, to the Tool Engineer, are stepping stones or stumbling blocks—depending upon the manner and the extent in which he uses them."

PRODUCTION PERSPECTIVES

(Continued from page 60)

a designer for 40 years by the Woodward & Powell Co., manufacturers of machinery and tools. He retired five years ago.

Manufacturing employment in Rhode Island was slightly lower in January than in December, but was up 20 per cent, from January, 1938, according to figures released by Director of Labor Thomas F. McMahon. Workers in 288 Rhode Island establishments numbered 71,178, in January, an increase of 11,680 from the 59,498 employed in January, 1938. In December 72,125 workers were employed.

Providence Machine & Tool Co. has been organized in Providence by Samuel P. White, James V. Pugliesie and LeRoy V. Elder.

The **War Department has awarded** a $22,350 **contract** for drilling, milling and tapping machines **to the Kingsbury Machine Tool Corp.,** Keene, N.H.

The International Harvester Company is **pushing ahead with its $3,000,000 modernization program on its Chicago tractor plant.** A **factory addition costing $1,000,000** has already been constructed, and the remainder appropriation for this purpose will be expended in 1940. In addition to this, **$800,000** will be **spent this year for new machinery** and rehabilitation of existing equipment at this plant. A new low priced tractor is to be brought out, which will create keen competition in that field. **Arrangements for factory facilities are under way which will provide for quantity production.** The company's complete modernization program includes other plants. Work has already been started on the Milwaukee, Rock Island, and Cincinnati plants. The total amount to be spent on the various plants is $11,000,000.

The Falk Corporation, Milwaukee, recently announced changes in its engineering department **with the promotion of Louis W. Falk** to executive engineer and **W. P. Schmitter as chief engineer.**

LOST AT ANNUAL DINNER—

a valued scarf pin at the Annual banquet in Detroit, March 16th at the Book-Cadillac Hotel. It has a medium sized diamond, in a circular converse setting, platinum top. Finder please return to THE TOOL ENGINEER.

BARBER B-C COLMAN
Combination Sharpening Machine
for REAMERS
for HOBS
for MILLING CUTTERS
"By guess and by gosh", along with freehand grinding, is no longer necessary in sharpening reamers, hobs and milling cutters. For tools of all brands, in shops of all sizes, the B-C Combination Sharpening Machine offers positive mechanical control of diameter, helix, spacing, tooth face and blade form. Formerly some of these elements were more or less doubtful. The B-C Combination Sharpening Machine eliminates doubt, gives you positive control, accurate knowledge . . . and you get higher production and longer life out of the sharpened tools. Investigate! Write today for Bulletin 1486.
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Dumser & Schroeder
610 West Michigan St.

CUTTING TOOLS

(Continued from page 64)

proper cutting angles and other features of design. There is also sufficient metallurgical data published on proper heat treatments to obtain the best physical characteristics for any application. The information we lack most is production records giving comparisons of actual performances of the various High Speed Steels on the different production materials in general use by industry. The need of this information is a challenge to the American Society of Tool Engineers and is of such importance that it should certainly be given consideration as a technical project when this Society does begin to set up standards under its own name.

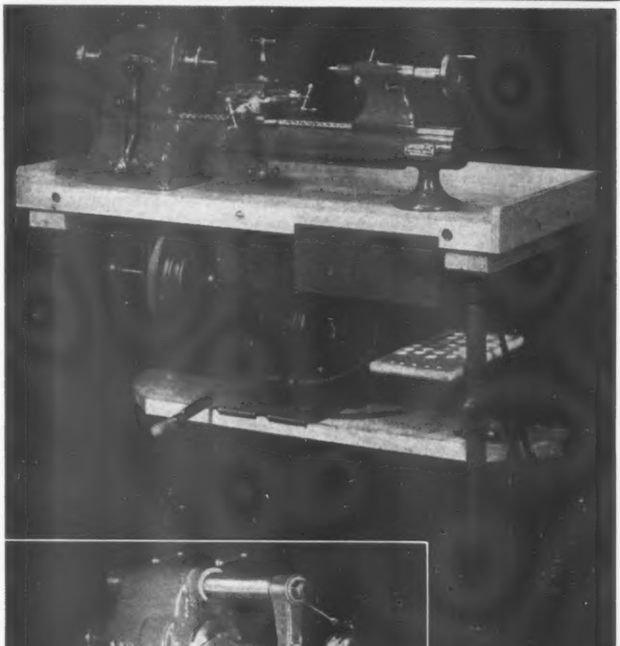
The second group of materials used in cutting tools consists of the non-ferrous alloys and is commonly known as the Stellite group. These materials have no annealed state, hence, are not forgeable and cannot be millworked. Their cutting efficiency depends upon the casting of the molten alloy mix into suitable molds, using either a centrifugal or gravity casting process, giving a chilling effect that results in a needle-like structure having high abrasion resistance and red hardness. They lack sufficient strength to be highly efficient in machining steel or to hold a fine cutting edge for finishing operations but give outstanding performance on roughing cuts in cast iron and non-ferrous parts. Since these materials can be machined only by grinding, they are definitely limited in their use because of the cost of grinding to intricate designs. Where quantities of identical tools warrant the cost of special molds, this disadvantage can be minimized but it remains an obstacle to the more general use of materials in this group. On the other hand, a material with no annealed state has a decided advantage on tools built up by welding because the welded section is usable without subsequent heat treatment. On cutting tools where the intricate design is not on the cutting portion, it is frequently possible to weld or braze a piece of mild steel to the cast cutting section and machine the intricate part of the design with less expense than would be involved were the entire tool cast solid. An example of this type of job is the manufacture of Stellite type blades for inserted serrated blade cutters by brazing a flat plate of cold drawn steel to the back of the Stellite blade and milling the required serrations in the soft steel back. A great deal of research work has been done in attempting to develop a hard-as-cast material similar to Stellite with physical properties variable by heat treatment to suit a wider range of applications than is at present possible. So far no such goal has been reached and we are forced to limit the usage of this type of cast alloy to the narrow field where its red hardness and resistance to abrasion are of sufficient importance to warrant the cost.

The Cemented Carbides made up the newest group of cutting tool materials. The producers of these Carbides have done such an excellent piece of work in informing the trade of the grades of Carbides available and the recommended applications and conditions most favorable to each of these grades that it seems superfluous to spend any time discussing this phase of our subject. The disadvantage of such extensive publicity is that it tends to build up the mistaken conception that the Cemented Carbides are a cure-all for all cutting tool troubles. Such is not the case. There are three basic types of Cemented Carbides, the straight Tungsten Carbides, the Tungsten-Tantalum Carbides, and the Tungsten-Titanium Carbides. Each type is made in several grades for specific applications. Care must be taken to specify the correct type and grade. On border line and special applications, it is always safest to contact the tip or tool supplier and abide by his recommendations. For optimum results, the machine and fixture set up must be very rigid with freedom from chatter and vibration. Machine tools must be capable of driving the work or the Carbide tools at surface speeds within those recommended for the particular grade of Carbide and the type of work. Equally important is the need for careful re-

(Continued on page 74)

HARDINGE
Cataract
PRECISION

Bench Lathes
Milling Machines
Hand Screw Machines
Tool-Room Lathes
Collets



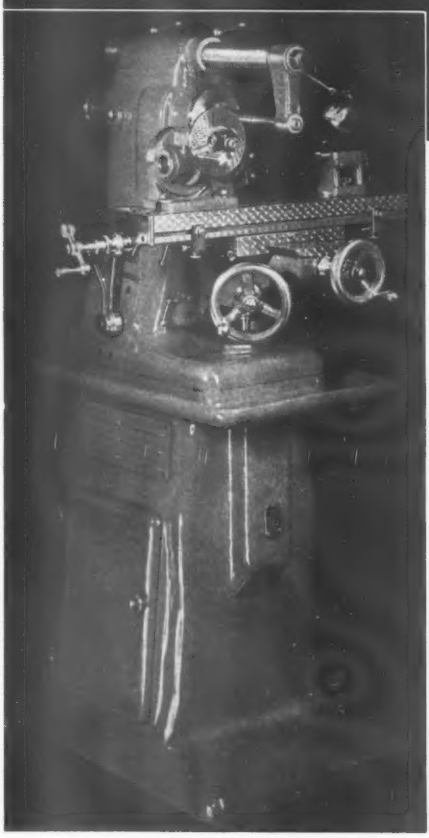
. . . for modern metal-working craftsmen

Hardinge "Cataract" Enclosed Head Precision Bench Lathes have many features which appeal to toolmakers who take pride in fine precision work and to production executives who appreciate the conveniences offered for fast, low cost accurate work.

For example:

Preloaded, duplex, double-row ball bearings in fully enclosed headstock, give extreme accuracy with positively no radial or end play. Turns perfectly true pieces. No adjusting of bearings—spindle not subject to bearing wear—permits use of modern tungsten carbide and diamond tools—produces excellent finish without polishing or grinding—modern electrical driving unit—high spindle speeds with six or eight speeds forward and reverse—brake for quick stopping of spindle—five sizes: ½" to 1" collet capacity, 7" or 9" swing—rigid construction, smooth performance and long life. Ask for Bulletin BB.

Hardinge "Cataract" Enclosed Head Precision Hand Screw Machines make economical short run work possible—ideal for rapid and accurate second operation work—Ask for Bulletin BBSM.



Hardinge "Cataract" Precision Milling Machines are another necessity well recognized for their outstanding precision performance in modern tool rooms. These rugged machines offer:

Enclosed headstock with preloaded ball bearings permits high spindle speeds with extreme accuracy—modern electric unit (enclosed in base) together with enclosed vee belt drive, gives eight forward and eight reverse spindle speeds. Feed Screws revolve in long adjustable nuts and have friction dials graduated to thousandths of an inch. Compact dimensions save space and promote convenient operation. Longitudinal travel 12". Traverse travel 6½". Vertical travel 7½". Centers swing 6" diameter. Bulletin BB5 on request.

Hardinge Collets for all makes of Lathes and Milling Machines: Since 1890 Hardinge Collets have been recognized for accuracy and durability. They are carried in stock for immediate delivery. Make certain that this type of collet carries the name Hardinge—it is an accuracy guarantee.

HARDINGE BROTHERS, INC.

ELMIRA, N. Y.

Chicago - New York - Hartford - Detroit - Philadelphia - Cleveland

The above machines are companion machines interchanging collets and attachments with the Hardinge High Speed Tool Room Lathe.

NEW *Equipment*

Micro Switch Actuated by Roller Leaf Spring

A roller leaf actuated Micro Switch is announced by the Micro Switch Corp., Freeport, Ill.

Designed for service in applications where small moving power is available to make or break circuits it is also adaptable to applications requiring low friction, minimum change of operating point through wear, and where roller action is needed between the cam and the switch lever. It can be used to control motors, heaters, solenoids, etc., from cams, slides, or rolls.

Small and compact, the overall size is 2½" long, 1⅜" high, and ¾" wide. Handles ½ h.p. Either the standard or Type Z Micro Switch can be obtained with the roller leaf actuator. Both are supplied in Metal-Clad housings. This switch is of single pole construction, and is furnished with normally open, normally closed, or double throw contact arrangements. Underwriters' listing.

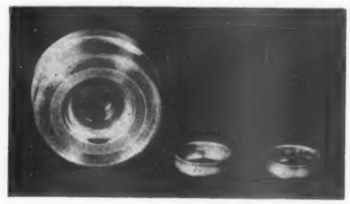
Leaf spring is ribbed stainless steel, which has been found most satisfactory from the standpoint of strength, spring tension, and life. Roller is $\frac{3}{16}$" wide, ⅜" diameter. It is case hardened and mounted on an oilless bronze bearing. The true roundness of the roller is held within .002".

New Hard Carbide Metal For Facing Dies

A new hard carbide insert for dies used in stamping and drawing automobile parts, chair casters, bottle caps, cans, electrical appliances, wire and other metal products for home and industrial use, has just been announced by McKenna Metals Co., 189 Lloyd Ave., Latrobe, Pa.

Recent tests conducted by a large caster manufacturer, indicate that dies faced with the new material, known as Kennametal, will outlast ordinary tool steel dies many times.

In regular production runs Kennametal-faced dies, according to the manufacturer, stamped out 70,000 chair casters before the first regrind, as compared with a total life of 14,000 pieces for the best tool steel die they had been using. The manufacturers point out that while this represents an increase of 500 percent in the number of pieces turned out, Kennametal-faced dies actually have an even greater advantage, for they may be reground several times before being discarded. The die in the illustration has stamped out 11,000 casters without any visible sign of year.



Steel casing with Kennametal insert shrunken into it, from which 11,000 chair casters of the type shown on the right have been stamped out.

The basic ingredient of Kennametal alloys is an intermetallic compound of tungsten-titanium carbide, corresponding to the formula WTiC2. Kennametal, the makers state, is now generally accepted as an ideal material for machine tool tips, because of its ability to machine steel heat-treated up to 500 Brinell, combining roughing and finishing in one operation, as well as its adaptability to the machining of softer metals. Eighteen standard styles of Kennametal tipped tools are available, as well as three standard styles of blanks for those who braze their own tools. However, special blanks can be supplied upon request.

(Continued on page 82)

THE IMPROVED M-B
"SUPER-SPEED" AIR GRINDER

THRILLING SPEEDS

AMAZING POWER

Steel Construction Throughout

POSITIVE QUICK ACTING AIR CONTROL VALVE

Operates on Air Pressures of 40-100 pounds

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Other Models, also Air Line Filters and Automatic Air Line Lubricators

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AMONG 14 OF OUR SHOP-MEN, ALL IN OUR SHOPS. That is worth something to you, but costs you nothing extra.

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Sold by leading Supply Dealers everywhere

GLENCO

COMPENSATING TOOLHOLDER

Corrects Machine Tool Misalignment By Producing TRUE and ACCURATE Holes

Also Manufacturers of

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COUNTERSINKS

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SLEEVES
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ADJUSTABLE ADAPTERS

ADJUSTABLE EXTENSION ASSEMBLIES
QUICK CHANGE CHUCKS
EXTENSION SOCKETS
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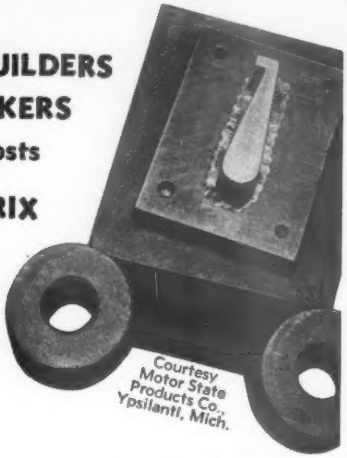
THE J. C. GLENZER CO.
DETROIT MICHIGAN

DIEMAKERS
MACHINE-BUILDERS
METALWORKERS
are reducing costs with
CERROMATRIX



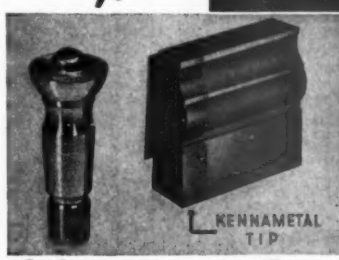
The punch was located in the die shown here by drilling an oversize hole in the punch plate and flowing CERRO-MATRIX around the punch. It is estimated that $15 was saved in its cost through the use of 30 cents worth of Cerromatrix. This regular production die is used for blanking 1/8" steel. It is only one of hundreds of applications where Cerromatrix is reducing costs in the metalworking field. Isn't it time to see what it can do for you?

Send for booklet

CERRO DE PASCO COPPER CORPORATION
44 Wall Street, New York, N.Y.
British Associates: Mining & Chemical Products Ltd., London
Canadian Representatives: Dominion Merchants Ltd., Montreal

Economize With **KENNAMETAL**

TOOLS AND BLANKS FOR MACHINING STEEL



Only **KENNAMETAL** *Permits*

★ Machining of tough metals such as Steel, heat-treated up to 500 Brinell, while COMBINING ROUGHING AND FINISHING IN ONE OPERATION.

★ Cutting speeds of two to six times greater than those of high speed steel.

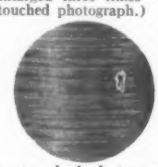
★ Ten to fifty times as many pieces obtained per grind of tool.

The KENNAMETAL-tipped Forming Tool in the above photograph will turn 500 steel tie-rod pins for automobiles at the rate of 300 per hour, and has a life of 30 regrinds or 15,000 pieces. Note the metal surface structures on the right.

KENNAMETAL is harder than the hardest tool steel.

Write for the No. 2 Kennametal Catalogue.
DETROIT REPRESENTATIVE:
Elwin M. Strickland
142 Lothrop Building, Detroit. Tyler 4-2975.

Section of above piece tooled with KENNAMETAL Form Tool. Note smooth structure. (Enlarged three times—unretouched photograph.)



Unretouched photograph. Section of similar piece, tooled with ordinary Tungsten Carbide tool. Note torn structure.

McKENNA METALS Co.
600 LLOYD AVENUE
LATROBE, PENNSYLVANIA, U.S.A.

Bottom view of standard Swartz Fixture showing separate compartments which prevent chips and cutting fluid discharges through the clamping surface from reaching operating mechanism.

Ask for Catalog 238M

SWARTZ TOOL PRODUCTS CO. INC.

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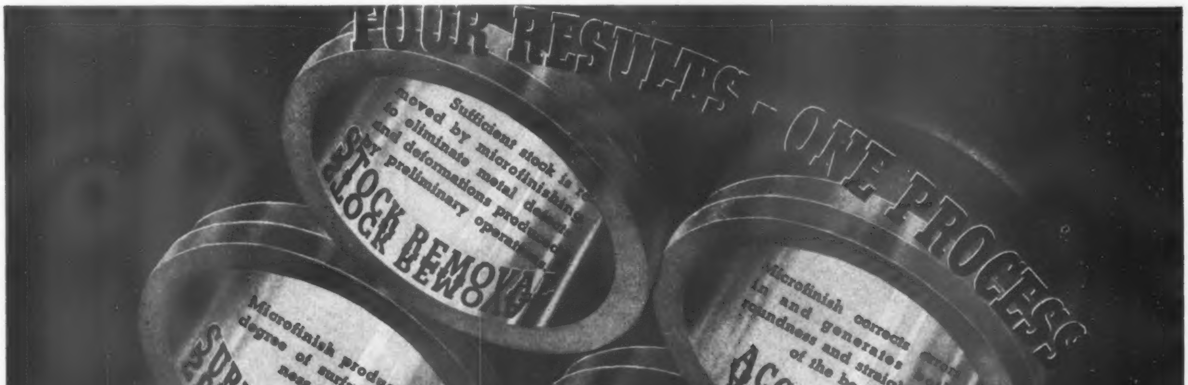
Chicago—Ernie Johnson
Canada—Hi-Speed Tools, Ltd., Galt, Ont.
St. Louis—Mill Supply & Mach. Co.

Oneida, N. Y.—W. F. Himmelsbach
Pittsburgh—J. W. Mull, Jr.
Toledo—J. W. Mull, Jr.
Philadelphia, Pa.—Morgan Tool & Equipment Co.



MICROMATIC HONE CORPORATION

7401 DUBOIS STREET - - - DETROIT, MICHIGAN

CUTTING TOOLS

(Continued from page 68)

sharpening of dulled tools. Many equipment manufacturers are offering specialized machine tools for grinding and finishing Cemented Carbide cutting tools. These work very well but no amount of equipment will overcome carelessness and careful control is the secret of success in applying and using Cemented Carbides.

Having briefly outlined the various materials available for use in cutting tools, we next are concerned with the problem of which tool material we should specify for use on machining each of the common production materials. Few production jobs are run under ideal conditions and any recommendations made should be used as applying only in a general way. It is frequently desirable to make use of several different materials in cutting tools used on the same part because the different conditions under which each operation is performed call for different physical characteristics in the tools. An alert tool engineer will choose his tool material not only because it is possible to machine a certain part with it, but also because the properties of the tool material indicate that it will make the most economical tools for that particular operation.

Production materials may be classified according to the type of chip that a single point turning tool would remove. They are either continuous chip materials or abrasive materials.

All of the production steels are classified as continuous chip materials. On the free machining S. A. E. analyses numbers 1112, x1330, x1340, and 1010 to 1040, either the 18-4-1 Tungsten or the Mo-Mas type of Molybdenum High Speed Steel has been very satisfactory. The slightly harder and tougher analyses such as S. A. E. 1040 to 1095, T1330 to T1340, the 32, 33, 41, 51 series and the 52100 call for the use of either the 18-4-2 Tungsten or the Mo-Mas Steels. The S. A. E. series, 23, 31, and 61 are more difficult to machine but the Cobalt bearing analyses of both the Tungsten and Molybdenum steels have worked very well. The choice of the best tool material for machining stainless steels, cast steels, or manganese steels depends considerably on factors other than the analysis of the part but the most successful seem to be the 8% or 12% Cobalt Tungsten steels or the 8% Cobalt Molybdenum steel. We do not recommend the use of the Stellite group tool materials for use on continuous chip operations although we know that they are being used to some extent with apparent satisfaction. The Tantalum and Titanium Carbides are proving very efficient on some operations on continuous chip materials on light roughing and finishing cuts where the conditions are favorable for their success. We may expect the Cemeted Carbides to become more generally used on continuous chip materials as the modern machine tools with high surface speeds replace older equipment. The present Cemented Carbides have not been very successful on heavy roughing or intermittent cuts and cannot be recommended on such applications with a definite assurance of satisfaction.

In the group of abrasive materials are found the cast irons and the non-ferrous materials. Tools with high abrasion resistance are needed for efficient machining of this group. Where the design of the cutting tool does not permit the use of any of the Stellite materials or the straight Tungsten Carbides, the 18-4-3¼ analysis of Tungsten High Speed Steel has given great satisfaction. Various secondary case treatments for High Speed Steels are available that have shown real improvement in cutting performance when used on tools for abrasive operations. The thing to remember about these secondary treatments is that they form a hard case only, and, if the design of the tool is such that the case is removed at each re-sharpening, it adds to maintenance costs to treat the tools every time they are sharpened. The Stellite alloys work best under abrasive conditions and are sharpened. The Stellite alloys work best under abrasive conditions and are particularly useful on cast irons where the cutting tool design permits the use of these cast alloys. The straight Tungsten Carbides give sensational performance under

(Continued on page 81)

There's A Counterbore That Will Really CUT TOOL COSTS!

Visitors to the A.S.T.E. Show were definitely "sold" on the Putnam Continuous Pilot Counterbore. This is the counterbore in which the pilot is continuous throughout the entire fluted portion of the tool—an exclusive design that provides exceptionally long cutting service from every counterbore.

Receiving even more attention were the Putnam End Mills. They were not only on display in the Putnam Booth, but were being used throughout the Show for demonstration purposes on machines in the exhibits of other manufacturers who are regular Putnam customers. For the extreme interest shown in these products—as well as in our reamers and grinding fixtures—we wish to express our sincere appreciation.

PUTNAM TOOL CO.

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Our congratulations for the outstandingly successful A.S.T.E. Machine & Tool Progress Exhibition. We cordially invite Tool Engineers to visit

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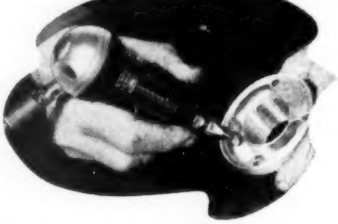

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Write for descriptive bulletin and free trial offer.

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In use by the LEADERS in all metal working industries

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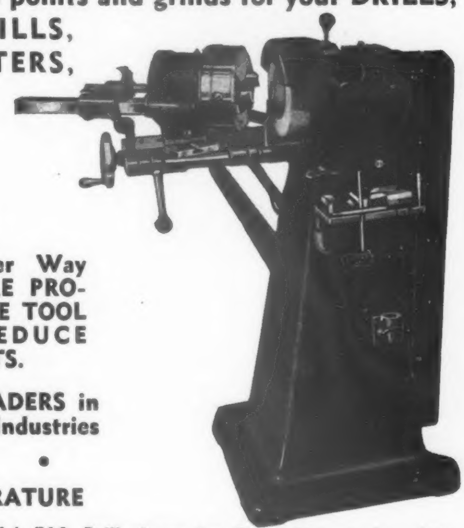

Universal Tool and Cutter Grinder—Easy to set up—Easy to operate—A real time saver.

Model 510 Drillpointer for Drills 1/4" to 3"—Automatic operation—Variable Clearances—Variable Angles.

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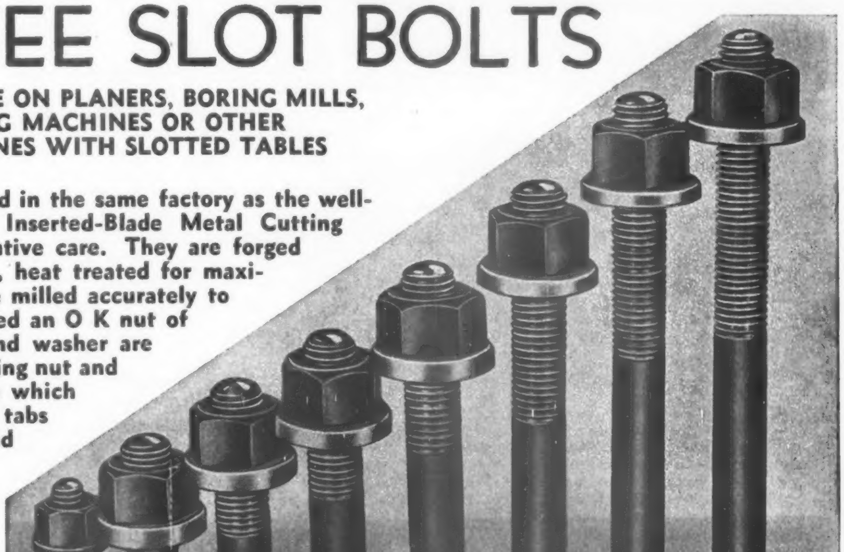
TRADE O K MARK

TEE SLOT BOLTS

FOR USE ON PLANERS, BORING MILLS, MILLING MACHINES OR OTHER MACHINES WITH SLOTTED TABLES



THESE bolts are manufactured in the same factory as the well-known "O K System of Inserted-Blade Metal Cutting Tools," and with the same relative care. They are forged of special medium carbon steel, heat treated for maximum toughness. The heads are milled accurately to size. With each bolt is furnished an O K nut of special design, in which nut and washer are incorporated into one unit. Having nut and washer integral eliminates time which is often wasted trying to keep tabs on separate washers. This flanged nut is made of the same tough steel as the bolt itself.

"O K" Tee Slot Bolts may be obtained in any length, from 2" long to 24". A circular completely describing and pricing the line will be sent you on request.

THE O K TOOL CO.
Shelton, Conn.

April Chapter Meetings

BALTIMORE

April 10, 1939—Dinner: 7:00 P.M. Sears Roebuck Auditorium, North Ave., at Hartford. Technical Session 8:00 P.M.

Sponsor: The Standard Oil Co., of America. The motion picture production "Design For Power," will be shown.

Reservation: Call L. MacGregor, 501 Hollen Road, Baltimore, TUX. 4436. Dinner tickets $1.00.

BRIDGEPORT

April 13, 1939—Dinner 6:30 P.M. at Mary Journey's Inn. Installation of Officers.

Speaker: L. Heres DeWyk, Consulting Engineer.

Subject: "Hydraulic Press Tools & Drawing Dies."

Make reservations with secretary.

BUFFALO

April 3, 1939—Dinner 7:00 P.M. Riviera Restaurant, 454 Pearl St. Technical Session at 8:00 P.M. by General Electric Company.

Speaker: R. H. Rogers.

May 1, 1939—Dinner 7:00 P.M. Riviera Restaurant, 454 Pearl St. Technical Session at 8:00 P.M. by Chrysler Corp.

Speaker: A. M. Swigert.

Subject: "Super Finish."

CHICAGO

April 3, 1939—5:30 opening of exhibits. Dinner 6:30 P.M. $1.00 at Midwest Athletic Club, 6 North Hamlin Avenue. 7:45 Entertainment by Prof. R. E. Oakes. Technical Session at 8:30 P.M.

Speaker: R. L. Wilcox, of The New Jersey Link Sales Company.

Subject: "Die Casting, The Modern Fabrication Process."

Reservation: Mail or phone reservations for dinner to the Midwest Athletic Club Catering Dept., 6 N. Hamlin Avenue. Chicago, Phone Van Buren 8200.

In connection with this meeting a number of manufacturers will exhibit their products.

Admission by Membership Cadr .Guests pay 25 cents.

DAYTON

April 10, 1939—6:30 P.M. Gibbons Hotel.

Speaker: Malcolm F. Judkins, Chief Eng. Firthite Division, Firth Sterling Steel Co.

Subject: Firthite Sintered Carbides—Methods of Mfg. & Tool Design.

Reservation: Call Walter Olt, Fu-3113 or by card.

DETROIT

April 13, 1939—Dinner at 6:30 P.M., Hotel Fort Shelby, Spanish Grill Room. Installation of officers.

Speaker: Don Flater, Factory Manager, Chrysler Corp. Bethlehem Steel Co. will show a movie "Building of the Golden Gate Bridge."

Tax: $1.50 per plate.

MILWAUKEE

April 13, 1939—

Speaker: H. J. Stagg, from The Crucible Steel Company of America.

NEW YORK—NEW JERSEY

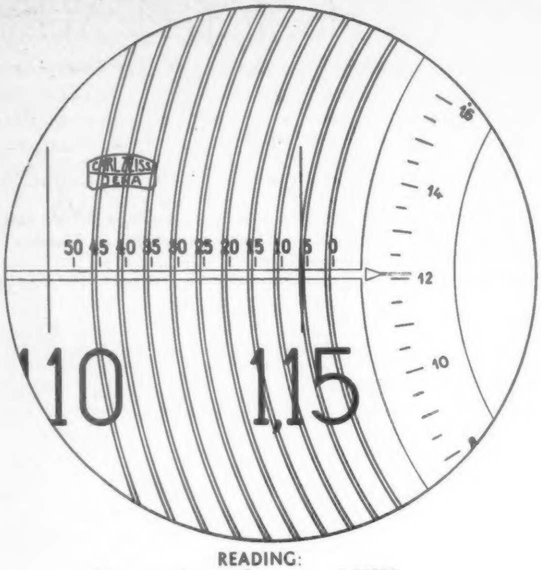
April 11, 1939—Dinner 6:30, meeting 8 P.M. Robert Treat Hotel, Newark, N. J.

Speaker: Mario Martellotti, Research Engineer, Cincinnati Milling Machines & Cincinnati Grinders, Inc.

Subject: "Formation of the Built-Up Edge in Metal Cutting."

Reservation: Ben C. Brosheer, Medallion 3-0700.

(Continued on page 80)



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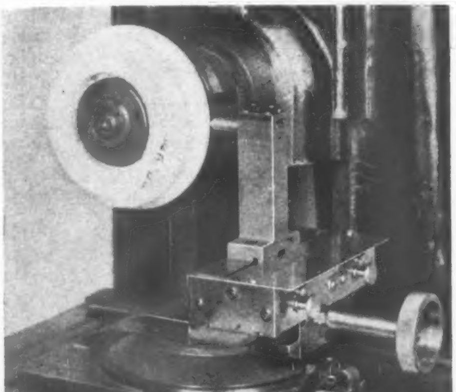
VINCO ANGLE TANGENT TO RADIUS DRESSER

for Internal, External and Surface Grinding Machines

Patented June 5, 1934, other patents pending.



One of the outstanding features of the Vinco Dresser is the basic patented principle of dressing angles and radii on abrasive wheels from the same axis without moving the diamond, angles and radii are always accurate and tangent. The illustration above shows The Vinco Dresser in use on a surface grinder dressing angles and radii on an abrasive wheel. The Vinco Dresser is precision made by highly skilled mechanics. Dresser parts subject to wear are hardened, rough ground, normalized, finish ground and lapped. Stops on the Index Plate permit the setting of the Dresser at any desired angle for production grinding. The Vinco Dresser will save you 75 per cent in dressing costs and eliminate all your worry. It is fully guaranteed to be satisfactory.

Send for Descriptive Circular

VINCO TOOL COMPANY

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BRADFORD

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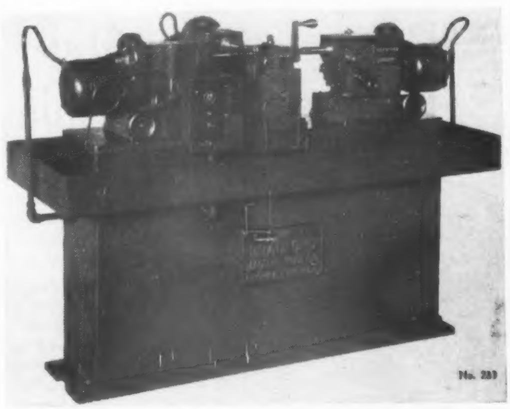

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Write for descriptive literature on this and other BRADFORD cost-saving equipment.

THE BRADFORD MACHINE TOOL CO.

Cincinnati   (Established 1840)   Ohio

Dealers wanted in some territories.

Chapter Meetings for April

(Continued from page 78)

PITTSBURGH

April 14, 1939—6:30 P.M. McCann's Dining Room, Diamond and Ferry Streets, Pittsburgh, Pa.

Speaker: Mr. J. P. Gill, Chief Metallurgist, Vanadium Alloys Steel Company, also Vice President, American Society for Metals.

Subject: "Modern High Speed Steel."

Reservation: Call Miss Wingard, Br. 1500, Extension 9264.

ROCHESTER

April 21, 1939—Dinner 6:30 P.M. Todd Union. Meeting 8:00 P.M. Strong Auditorium. There will be no regular meeting of our chapter in April. On above date the Rochester Chapter A.S.M. has invited us to meet with them for their session with Dave Wallace. This is a part of their three-day symposium and they are joined by Buffalo, Elmira, and Syracuse Chapters of A.S.M.

Speaker: Dave A. Wallace, President, Chrysler Div. of Chrysler Corp.

Subject: "Superfinish."

Reservation necessary for dinner only—$1.00.

ROCKFORD

April 13, 1939—5:00 P.M. until Midnight. Dinner 6:30. Hotel Faust. Entire eleventh floor—Both ballrooms, private lobby and check room. Technical session furnished by Haynes Stellite Co.

Speaker: Mr. E. F. Smith, Stellite Div., Chicago. Also demonstration on flame hardening.

Reservations: By April 11 to Allis Chalmers, Talcott Bldg., Maine 6270.

SCHENECTADY

April 6, 1939—8:00 P. M. Rice Hall. General Electric Co., Schenectady, N. Y.

Speaker: A. M. Swigert

Subject: "Superfinish."

Members are requested to bring a guest.

ST. LOUIS

April 6, 1939—Dinner 6:30 P.M. York Hotel.

Speaker: Millard Romaine, of The Cincinnati Milling Mach. Co.

Subject: "Surface Broaching of Metals."

Reservation: C. J. Steinman, c/o York Hotel.

TOLEDO

April 4, 1939—6:30 P.M. Commodore Perry Hotel.

Speaker: E. L. Bowsher, Superintendent of Schools.

Reservation: L. E. Rennell, 206 Crawford, Home, JE-2900-M; Business, LA-2121.

Invited Guests—
- **Mr. Frazier, President, Willys-Overland Inc.**
- **Mr. Donkel, President, Kent-Owens Co.**
- **Mr. Mogford, Vice-President, Spicer Mfg. Corp.**
- **Mr. Faye, Vice-President, Electric Auto-Lite Co.**
- **Mr. Pack, Vice-President, Doehler Die Casting Co.**

Toast Master—Mr. M. Myers.

TRI-CITY

(Moline—Rock Island—Davenport)

April 12, 1939—Dinner at 6:30, at Leclaire Hotel in Moline. Meeting at 7:30.

Speaker: Mr. Ransom of the Barber-Colman Co.

Subject: "Principles of Hobbing."

CUTTING TOOLS

(Continued from page 74)

favorable conditions when used on abrasive applications. No other tool material can approach the performance of the Tungsten Carbides when they are properly specified and handled on the job. The choice of the most economical tool material for abrasive conditions is the most difficult of all cutting tool material specifications because of the wide divergence in initial cost and maintenance expense between the High Speed Steels, the Stellites, and the Tungsten Carbides. This divergence is most apparent in multi-point tools, but, as we gather more experience with tools of high initial cost, we will be able to specify them with less fear and trembling through knowing what to expect in the way of performance.

Let us consider the information available to Tool Engineers that will influence the choice of cutting tool materials for particular applications. We must first have a thorough knowledge of the physical characteristics and design of the part, the operation desired, and the machine tool and accessory fixtures, etc., involved. If the surface speed of the operation is fixed, we must choose a tool material that will stand up on the part material at the limited surface speed, but if the surface speed is variable, we have a better opportunity to develop the most economical tooling. If the design of the cutting tool is limited, we must specify a tool material whose mechanical limitations do not conflict with the necessary design. If the cut is roughing or finishing, continuous or intermittent, we can further narrow down the field of available tool material. The most difficult aspect of tool material specification has to do with maintenance costs in relation to production. This involves a study of the number of pieces machined between sharpenings, the number of possible sharpenings, the cost of down time while changing tools, and the cost of re-sharpening. Such costs are somewhat intangible but are vital in considering the overall comparative cost of different tool materials. As previously mentioned, these figures are gradually being compiled in the light of experience and are a valuable addition to the fund of information available to tool engineers. On long production runs it is wise to start using the cheapest tooling that appears to have the necessary qualifications with the higher cost alternatives held in reserve in case of failure of the cheaper. In the rush to avail ourselves of the possibilities of new designs and materials, we must not lose sight of the capabilities of simple, inexpensive cutting tools.

It is sometimes hard to believe that there are not always tool materials available to satisfy any operation we might care to set up. We have been engulfed in trade names and extravagant claims so long that it is difficult to realize that there is a field for which no suitable tool material has previously been introduced. This field of operations lies between the accepted range of the forged High Speed Steels and the Cemented Carbides. High Speed Steels are not forgeable when alloyed beyond fairly low limits and hence the forged High Speed Steels cannot be alloyed to extend the range of their physical characteristics to meet the range of the Cemented Carbides. The limitations of the sintering process and the need of keeping the carbide to bond ratio high enough for cutting efficiency prevent the manufacture of Cemented Carbides with physical characteristics ranging down to those of the forged High Speed Steels. Those of you who have had an opportunity to visit the various booths in this splendid exhibition have probably seen the demonstration of a Cast High Speed Steel specifically developed to bridge this gap. The proof of the pudding is still in the eating and experience with this type of material will soon show whether it will perform on general production in as interesting a fashion as it has performed so far.

It is useless to try to predict what future developments will bring in new cutting tool designs and materials. We have a tremendous amount of work to do in correlating the experiences with present designs and materials before we can be sure that we are getting the maximum value out of expenditures for cutting tools. That is the real problem for Tool Engineers to solve.

NEW EQUIPMENT

(Continued from page 70)

New Corrosion Resistant Bearings

A new development, making it possible to use ball and roller bearings in services involving exposure to many corrosive liquids and gases, is claimed by Bantam Bearings Corporation of South Bend, Indiana, which announces production of bearings made of "K" Monel in all required sizes and types.

This nickel-copper alloy can be heat-treated to provide hardness, wear-resistance and strength not ordinarily associated with non-ferrous bearing materials. Its resistance to corrosion, it is stated, is such that it can withstand the action of many acids, most alkalies and a wide range of gases. Furthermore, the producers state, it retains high mechanical properties over a range from low sub-zero temperatures to above 800° F. It is non-magnetic down to —110° F.

Many uses already have been indicated for these new bearings in food handling equipment, chemical plants, motor boat service and elsewhere where it is not practical to protect ordinary bearings with housings or grease and where slight changes in design and increases in diameters over corrodible materials, are permissible.

Billings Cut-Off Tool for Round Stock

A new manually operated cut-off tool for cutting drill rod, wire or the smaller diameters of bar stock is announced by the Billings & Spencer Co., Hartford, Conn.

This is much needed, yet inexpensive, equipment for Tool Rooms, Tool Cribs, Stock Bins and Stock Rooms. It is a labor-and-time saving tool which will cleanly cut off drill rod and wire from 0 to ¼" round inclusive without leaving a burr. The severed ends of the stock are not distorted and are free for entry for additional cuts. It is fast in action, easy to operate. Since it is designd to utilize the applied leverage directly, it requires only a minimum of exertion. It can be secured directly to the bench, or may be set up in a vise as required in only a few seconds time.

Constructed of drop forgings, carefully machined and properly heat-treated, it is designed to give many years of service. The bar is 15¾" long, ⅞" in diameter, finished in gray "Duro" with bright red end. The cut-off cam and block are in natural rust-proof finish.

Detroit Rex Products Expands Sheet Metal Division

In order to expand their services to industry so as to include not only metal cleaning but also certain production phases of finishing, the Detroit Rex Products Co., 13023 Hillview Avenue, Detroit, Michigan has expanded their sheet metal manufacturing division.

Mr. I. J. Belanger, formerly of the Belanger Fan and Oven Company, Detroit, Michigan has been appoined manager of this division.

Included under this division are the manufacturing, marketing, installation, and servicing of industrial oven equipment, bonderite and other rust proofing systems, alkali washers and stripping machines, and general sheet metal work such as tankage, bins, etc. This division will also have supervision of spray booth installations.

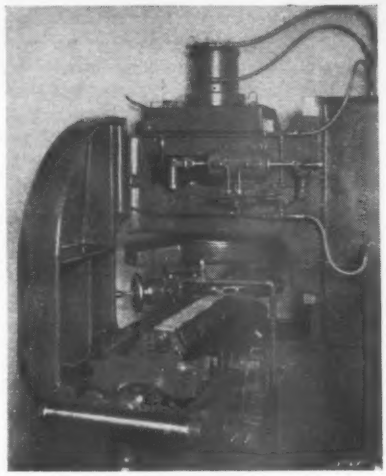
New Heavy Duty Rack Type Gear Shaver

A new, heavy duty variation of its well-known rack-type gear finisher has been developed by Michigan Tool Company, Detroit. In addition to having a heavier and more rigid head construction, the finisher also incorporates a number of operating improvements.

Included is a new hydraulic mechanism for continuous oscillation of the gear carrying arbor, moving the gear across the rack and back, while the rack is moving back and forth endwise—thus distributing the wear evenly over the rack.

The hydraulic mechanism is interlocked with the machine controls, starting and stopping with the machine. The length of the oscillating stroke is adjustable, as is the speed of oscillation.

The more rigid design is said to increase cutting speed, while contributing further to gear accuracy. The method of supporting head slides and work arbor has been changed for better balance of the slides over the center of the gear—eliminating overhang of the work with respect to slides.

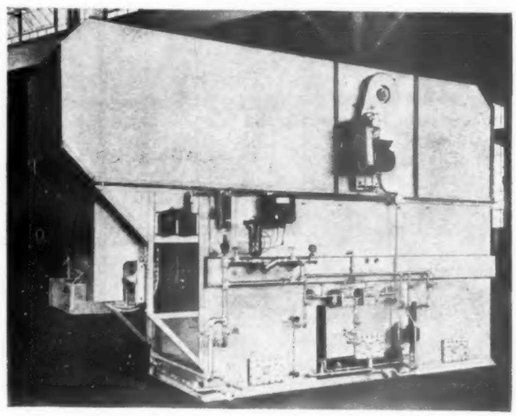


New Heavy Duty Rack-Type Gear Shaver by Michigan Tool Co.

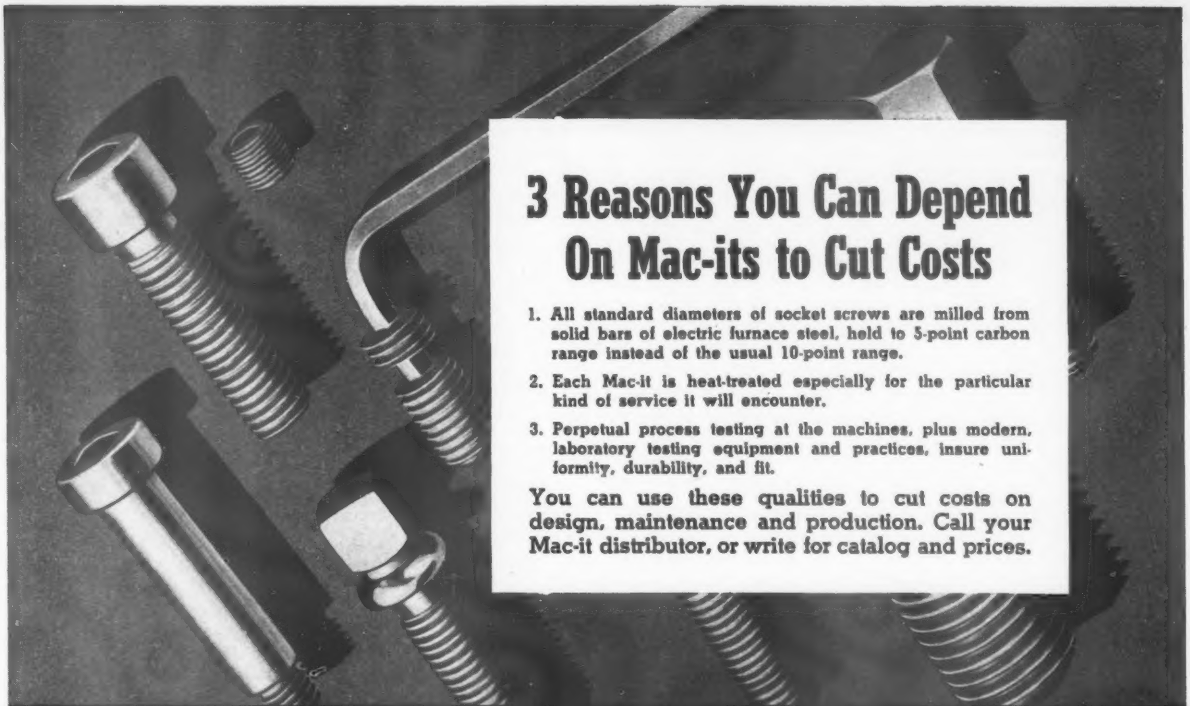
A one shot system of lubrication has also been incorporated in the machine, to simplify lubrication of slides and bearings.

Louis Allis New Safety Motor Features

The Louis Allis Company, Milwaukee, Wisconsin, have announced an important electric motor development—a completely brand new line of both alternating and direct current explosion-proof motors that they state makes possible a new high in electric motor dependability, convenience, long-life and safety. This new modern streamline motor was designed in collaboration with one of the leading industrial stylists in the United States—and is the last word in modern industrial streamlining. Eighteen separate and distinct major mechanical and electrical improvements, several of which are exclusive patented features, are incorporated in this new line of explosion-proof electric motors. Mention "The Tool Engineer" when writing for a complete booklet illustrating and describing in detail the advantages claimed for these new motors.



New Degreasing Equipment by Detroit Rex Products Company



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TOOL ENGINEERS QUALIFY

(Continued from page 15)

Importance of Contacts with Product Engineer

There are many points that enter into the design of a product which should be carefully noted by the Tool Engineer to see that they lend toward economical manufacture. The average draftsmen working on Product Engineering may know very little regarding foundry practice, stamping practice, or forging. While the Tool Engineer may not have all the information on these subjects, the nature of his work is such that he must have a better insight into the practices than the average Product Engineer, as he is constantly in contact with good and bad practices. He can be of great help to the Product Engineer by passing on any information which he may have after scrutinizing the original design. Tool Engineer's experience with machine shop usually exceeds the Production Engineer's experience along this line due to his being responsible for machine shop practice. He who is successful keeps informed of the latest machine developments and by so doing has an advantage over the Parts Designer Engineer.

Through Time Study the Tool Engineer is able to determine whether grinding is more advantageous than milling, or whether diamond boring is superior to reaming. The size of plant equipment, such as plating tanks, enamel facilities, etc., are factors in determining shop practice. These factors are usually unknown to the unit parts designer and his main thought is to design the product and leave the responsibility of procuring equipment for producing the job to the Tool and Plant Engineer. Tolerances specified are of first importance to the Product Engineer, while the Tool Engineer must give his first thought to economical shop practice, although never forgetting the quality of the product. Tolerances on parts that are unnecessary for a good unit should be called to the attention of the designer if economy demands it. This would apply to decimal dimensions, hardness of material, surface finishes, etc. Surface finishes are very important today and were brought about by the development of suitable gauges that definitely determine good or bad finishes. The work of the Tool Engineer is to produce the parts designed in the manner in which the engineer specifies, but close cooperation between the two will ofttimes result in an equally good product with more economical production.

A Valuable Source of Information

I actually believe that I have obtained more technical information from Product Engineers than any other source available in manufacturing. These men, as a rule, have a vivid imagination, a lot of experience, together with laboratory facilities, research departments, and records of performances and findings that make them a fine source of information. We are somewhat prone to consider them as impractical in some of their specifications, throwing a hardship on the Tool Engineer, to produce as specified. We will all have to admit, however, that their designs, with what we considered impractical specifications, have often forced the Tool Engineer and the machine builder to provide equipment that would machine parts to the specifications set up by the Parts Designer.

I can well remember, when working as a Tool Engineer, the first blue print that was issued to me on a part on which the engineer had specified that a hole be matched to a half thousandths limit, whereas, our shop practice had never been closer than one and a half thousandths. Naturally, this tolerance was looked upon with considerable reflection. I now realize that consistent specifications of these tolerances have been effective in producing the high quality motors, etc., produced today. Therefore, in taking your comments back to the originator of the design, just be certain that the things he has specified are not contributing to a better product and utilize your own ingenuity to provide equipment that will still produce this unit and do it economically.

After all, Product Engineers most certainly have had a great hand in persuading the Tool Engineer and machine tool builder to be more aggressive and to produce equipment that is as efficient and accurate as it is today. You cannot afford not to be in close contact with this branch of manufacturing.

PRICE TAG ADDED LAST

Knowing fine machinery, you instantly appreciate the heft and sturdiness of The Haskins Tapper. You realize that only precision engineering BUILT INTO the machine can result in precision tolerances in the finished piece. You KNOW that high speed, long life and dependability in your plant are not the results of production to a price in our plant. And you'll expect to pay more for your Haskins Tapper in the beginning because you know it's MORE THAN WORTH THE DIFFERENCE in the end!

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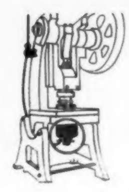
ORIGINATORS AND MANUFACTURERS OF HELICAL FLUTED TAPER PIN REAMERS

THE GAMMONS-HOLMAN CO., MANCHESTER, CONNECTICUT



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